Limax variegatus, Ehrenb.
Daudebardia syriaca, Roth.
Helix pratensis, Fér.
—— *obstructa*, Fér.
—— *arenosa*, Ziegl.
—— *simulata*, Fér.
—— *genezerethana*, Mouss.
—— *improbata*, Mouss.
—— *crispulata*, Mouss.
—— *joppensis*, Roth.
—— *neglecta*, Drap.
Bulimus benjamiticus, Benson.
—— (*Chondrus*) *lamelliferus*, Rossm.
Pupa chondriformis, Mouss.
Clausilia ehrenbergii, Roth.
Glandina liesvillei, Bourg.
Limnæus truncatulus, Gm.
Cyclostoma elegans, Drap.
Bithinia saulcyi, Bourg.
—— *gaillardoti*, Bourg.
—— *hawadieriana*, Bourg.
—— *moquiniana*, Bourg.
Melania judaica, Roth.
Neritina syriaca, Bourg.
Cyrena crassula, Mouss.
Unio requieni, Mich.
—— *litoralis*, Lam.

I may state that I have seen type specimens of *Helix joppensis*, *Bulimus benjamiticus*, and *Melania judaica*, the two former of which are unquestionably good species. *Helix genezerethana* is perhaps only a large variety of *H. nummus*, Ehrenb.

8. Contributions towards a more Complete Knowledge of the Axial Skeleton in the Primates. By St. George Mivart, F.Z.S. & L.S., Lecturer on Comparative Anatomy at St. Mary's Hospital.

The great interest which has been felt of late as to the value and extent of the anatomical resemblances and differences between Man and the rest of the Primates has led to many researches, which have, however, been mainly directed to a consideration of the head and extremities, and especially of the bony framework of those parts.

To the various details given by Cuvier and others, respecting the cranial structure of the highest Apes as compared with each other and with Man, such careful and minute comparisons have from time to time been added by Professor Owen, in his well-known and justly esteemed memoirs on the subject, published in the 'Transactions' of this Society, and last of all by Professor Huxley, in his elaborate comparison of their immature condition (soon to appear in the Society's Transactions), that little remains to be added to our knowledge on the subject; while the differences between the skulls of the highest Apes and those of the lower forms of the order have been investigated by Professor Vrolik, M. de Blainville, and other writers.

As regards the bones of the limbs, there is again but little to add to the comparisons already instituted between Man and the highest Apes in this respect, though perhaps some additional points of interest may yet result from a further investigation of the details of these structures in the lower groups.

The spinal column of the Primates has also been more or less noticed by Cuvier * and by Meckel †; and the structure of the lower Apes, in this respect, compared with that of the higher, by Professor Vrolik ‡ and by M. de Blainville §. Also Professor Huxley, in his Hunterian Lectures for 1864, has given many further details ‖ on the subject.

But the most complete and detailed description and comparison of the spinal column, as it exists in Man and in the highest Apes, is to be found in Professor Owen's memoir on the skeleton of the Gorilla ¶; and it has appeared to me probable that the results of an extension of similar minute observations carried through every family of the order, comparing the various forms with each other and with Man, may not be without a certain interest as exhibiting the manner in which the human vertebral column becomes modified (so to speak) into that of the ordinary mammal, as adding a further clue to the affinities of the different groups composing the order, and, finally, as another contribution (however small a one) to a more correct appreciation of the anatomical and zoological value of the structural differences between Man and the highest of the Apes.

In the following summary of such results, many facts are stated which are already well known, or have been previously noticed, but the mention of which, nevertheless, could not be omitted.

Rich as are the collections of the British Museum and the Royal College of Surgeons, there are nevertheless several genera of the order of which no skeleton exists in either, and others of which there is no skeleton *unmounted*—deficiencies necessarily rendering the following account still more imperfect than it would otherwise be.

As a preliminary, it is necessary to state the arrangement here adopted, with respect to the families, subfamilies, and genera of the order, though this is not the place to give the characters on which this classification reposes. The Primates seem to me to be most naturally divisible as follows :—

* Leçons d'Anat. Comp., 2nd edition, 1835.

† Traité Général d'Anat. Comp., traduit de l'Allemand par MM. Riester et Alph. Sanson, 1828.

‡ Recherches d'Anat. Comp. sur le Chimpansé. Amsterdam, 1841.

§ Ostéographie—Mammifères, Primates, Pithecus, Cebus, Lemur.

‖ Reported in the 'Medical Times' for 1864.

¶ Trans. Zool. Soc. vol. iv. p. 89, pls. 33, 34, 35, 36.

Suborder I. ANTHROPOIDEA*.

Fam. I. HOMINIDÆ			Homo.
II. SIMIIDÆ	Subfam.†	1. *Simiinæ*	Troglodytes. Simia. Hylobates.
		2. *Semnopithecinæ*	Semnopithecus. Colobus.
		3. *Cynopithecinæ*	Cercopithecus. Macacus. Inuus. Cynocephalus.
III. CEBIDÆ	Subfam.	1. *Cebinæ*	Ateles. Lagothrix. Cebus.
		2. *Mycetinæ*	Mycetes.
		3. *Pitheciinæ*	Pithecia. Brachyurus.
		4. *Nyctipithecinæ*	Callithrix. Chrysothrix. Nyctipithecus.
IV. HAPALIDÆ			Hapale.

Suborder II. LEMUROIDEA ‡.

V. LEMURIDÆ	Subfam.	1. *Indrisinæ*	Indris, &c.
		2. *Lemurinæ*	Lemur, &c.
		3. *Nycticebinæ*	Nycticebus. Loris. Perodicticus. Arctocebus.
		4. *Galagininæ*	Galago.
VI. TARSIIDÆ			Tarsius.
VII. CHEIROMYIDÆ			Cheiromys.

Throughout the Primates the spinal column consists of the same regions as it does in Man, the most obvious difference being the very considerable increase of the coccygeal vertebræ, both as regards number and size, in the great majority of species.

With the exception of this coccygeal or caudal region, the other parts of the spine bear more or less the same proportions one to another as in Man.

CERVICAL VERTEBRÆ.

The length of the cervical region, as compared to that of the dorsal region, is throughout the *Anthropoidea* pretty uniform, the first being from rather more than a third to about half the length of the second. In the *Lemuroidea* we find a greater variation, the proportion of the cervical region to the dorsal ranging from considerably less than a third, e. g. *Loris*, to as much as two-thirds, as in *Indris*.

The proportion of length to breadth of the cervical region is generally as about two to one in the *Anthropoidea*; but in *Hylobates* it

* See P. Z. S. 1864, p. 635.

† This subdivision was, I believe, first proposed by my late lamented friend, Mr. Martin, in his unfinished work on Mammals, entitled 'A Natural History of Man and Monkeys,' p. 361. I am doubtful whether the *Simiinæ* should not be raised to the rank of a family.

‡ For complete list of the genera of this suborder, see P. Z. S. 1864, p. 637.

is sometimes as three to one. In the *Lemuroidea* we again find a much greater range of variation; for in *Loris* and *Nycticebus* the length is not nearly twice the breadth (shorter relatively than in Man), while in *Indris* the cervical region of the spine is almost five times as long as broad.

In most of the Primates this region bears about the same proportion to the rest of the spinal column, exclusive of the tail or coccygeal vertebræ.

In *Hylobates*, *Cynocephalus*, and *Ateles* it is rather more elongated relatively than it is in Man. It attains its maximum of relative length, however, in *Indris*, where it exceeds one-fifth of the total length of the spine as above limited. On the other hand, in *Loris* it attains its minimum, the cervical region scarcely constituting more than one-tenth of the total length of the spine. Thus in the proportion of the cervical region to the whole trunk, as in its proportion to the dorsal region only, we find both extremes to exist in the suborder *Lemuroidea*, which contains the relatively longest, as also the relatively and absolutely shortest, neck to be found in the whole order.

Atlas.—This bone has a very similar form throughout the *Anthropoidea*.

In the *Lemuroidea* there is a greater range of variation.

In the highest Apes, *Troglodytes* and *Simia*, the atlas is exceedingly like that of Man, only the transverse process is relatively rather smaller and shorter, and its extremity more upcurved*.

This dorsal curvature of the extremity of the transverse process continues throughout the *Anthropoidea*; but in the *Lemuroidea* the ends of the transverse processes are generally bent more or less downwards.

The length of the transverse process, as compared to the total transverse diameter of the atlas, varies even in the same species; but in some of the *Semnopithecinæ*, *Cynopithecinæ*, and *Cebidæ* it is relatively less than in the *Simiinæ*, being in *Ateles*, *Mycetes*, and some *Macaci* but little, if any, more than one-fifth of the latter.

In the *Lemuroidea* this process attains its greatest relative size, being almost as long as one-third the total transverse diameter in *Indris*. In *Loris* and *Nycticebus*, on the other hand, it is less than one-fourth.

In all the *Anthropoidea* the transverse processes are more or less conical; but in the *Lemuroidea* they have often a flattened, plate-like form, being antero-posteriorly expanded at the distal end.

In the *Simiinæ* and in *Ateles*, as in Man, the neural arch is sometimes perforated, sometimes only grooved, by the vertebral artery; but in all the other genera† it is always perforated by it, and often two short bony canals exist on each side.

In the lower *Simiidæ* (e. g. *Cynocephalus*) the vertebra is thick and massive, the relative size of the canals being much reduced by the extent of ossification.

* *I. e.* bent *dorsally*, the spine in all cases being supposed to be horizontal, as it is in quadrupeds.

† I have only found one exception, *S. nasalis*, in the British Museum.

Ateles presents the opposite extreme, the canals being always of large size, if not, as has been mentioned, replaced by a mere groove.

A spinous process is very rarely present; but in a skeleton of *Cynocephalus mormon* *, in the Royal College of Surgeons' Museum, there is a distinct and pointed, though small, spinous process to the atlas; and Professor Owen † speaks of a distinct tubercular rudiment of such a process on the atlas of an old male Orang at Paris.

A hypapophysial tubercle or ridge, however, is very generally present, sometimes, as in *Mycetes* and *Lagothrix*, attaining a very large size, being produced backwards, beneath the axis, in a very remarkable manner ‡.

In all the *Anthropoidea* the two articular surfaces for the axis are quite distinct and separate from each other. In many of the *Lemuroidea*, however, they are confluent and united together in the middle line, so as to form but one articular surface for the axis; this is the case in *Lemur, Indris, Galago, Perodicticus,* and *Arctocebus*. In *Cheiromys, Nycticebus,* and *Loris,* however, we again find two separate articular surfaces.

Axis.—This vertebra, though in all Primates essentially similar to the axis of Man, has, in most species, but a simple unbifurcated spinous process; but in this, as in so many other details of vertebral structure, there is considerable individual variation. The process is strongly bifurcated in Man, and more or less so in the Orang, *Ateles, Hapale, Nycticebus,* and *Galago* §. In *Mycetes* (fig. 1, page 553) it is distinctly trifid; and it is sometimes more or less so in the Potto ||, Chimpanzee, and Gorilla, and sometimes even in the Orang ¶.

This process is produced forwards, curving over anteriorly in some, especially in *Ateles* (fig. 6) and *Mycetes, Lemur,* and *Indris*. It is more or less backwardly produced in the lower *Simiidæ*, very much so in *Lemur*, but not at all in *Indris*.

Throughout the *Anthropoidea* the neural laminæ of this vertebra have very similar proportions; but in some *Lemuroidea* we find a great increase in their antero-posterior as compared with their transverse diameter, *e. g.* in *Lemur* and *Indris*.

The transverse process curves more or less upwards at its extremity throughout the *Anthropoidea*; but scarcely so in *Lemur* and *Indris*, in which, moreover, the two transverse processes are so sharply bent backwards as to form an acute angle with each other, instead of nearly a rectangle as in the higher forms. The extremity of this process is scarcely ever bifurcated **.

* No. 4720 in the Osteological Collection.

† Owen, Trans. Zool. Soc. vol. iv. p. 96.

‡ It is nearly as much developed in two skeletons in the British Museum—one of *Colobus satanas* (no. 1180 *a*), and the other of *Colobus temminckii* (no. 778 *b*).

§ Besides the above forms, it is decidedly bifurcated in *Cercopithecus ruber* (no. 15 *b*) in the British Museum.

|| In skeleton no. 743 *c* in the British Museum.

¶ As in skeletons of Orangs (nos. 3 *i* and 43, 10, 2, 1) in the British Museum.

** In a Mandril's skeleton in the Museum of the Royal College of Surgeons (no. 4719) there is such a bifurcation, though only on one side. A trace of bifurcation exists also in *Perodicticus* and *Arctocebus*.

The odontoid process in some forms, *e. g. Ateles, Lemur*, and *Indris*, is much shorter relatively to the length of the axis than in Man; it is generally continued forwards nearly or quite in the same plane with the centrum, but rises anteriorly, forming a marked angle with the centrum, in *Lemur, Arctocebus*, and *Perodicticus*, but not so in *Nycticebus*.

The axis has, of course, two anterior zygapophysial articular surfaces in those forms in which the atlas has two posterior articular surfaces, and but one in those in which the latter are confluent. The body is very much prolonged backwards in many forms, so that its posterior articular surface looks more or less upwards. This is well seen in *Ateles*; but there is much individual variation in this respect.

The third Cervical Vertebra.—The spinous process of this vertebra presents great variations in different forms. In most races of Men* it is strongly bifurcated; but in none is it much elongated. In *Simia* and *Troglodytes*, however, it is very greatly elongated, and shows no trace of bifurcation. In all the other *Anthropoidea* it is the shortest of all the cervical spines, is sometimes directed forwards, and sometimes backwards, but is always quite simple, except in *Mycetes* (fig. 1), where it is more or less trifid, and therefore formed on the same type as is the spine of the axis in that genus.

In the *Lemuroidea* we again meet with a distinctly bifurcated spinous process in *Nycticebus*; and it is curious, that, while we find in this form a return in this respect to the human structure of the process, we find in other genera of the same subfamily (e. g. *Perodicticus* and *Arctocebus*) a lofty very elongated spine, similar to that existing in the Anthropoid genera *Troglodytes* and *Simia*. In *Lemur* and *Indris* the process is short and simple, as in most *Anthropoidea*; but in *Loris, Tarsius*, and *Cheiromys* it is very rudimentary. In *Galago*† it is absent; but two minute projections appear to repeat in this vertebra, and be serially homologous with, the lateral parts of the spine of the axis.

The neural laminæ have much the same proportion as in Man till we come to *Ateles*, where the antero-posterior as compared with the transverse diameter is first notably increased; but this elongation does not exist in the lower *Cebidæ*.

In *Lemur* the relative antero-posterior diameter is greatly augmented, reaching to nearly half the total breadth; and in *Indris* this proportion is still further increased to two-thirds. In the *Nycticebinæ* it again decreases. In *Indris* the neural laminæ are separated behind by an antero-posteriorly directed cleft or fissure‡, the neural spine arising from the anterior end of the vertebra only, and not from its middle or posterior end as in *Lemur* and *Ateles*.

The transverse process generally ends simply, without any bifurca-

* In the skeleton of a male Boschisman, preserved in the Museum of the Royal College of Surgeons, the spinous process is simple (Osteological Catalogue, vol. ii. p. 832, no. 5357). The same is the case in the skeleton of a female individual of the same race which is also in that museum.

† See skeleton of *Galago allenii* (no. 68 *d*) in British Museum.

‡ Noticed by Prof. Owen, 'Osteological Catalogue,' vol. ii. p. 717, no. 4631.

tion; but in Man it appears constantly to bifurcate; it does so also almost constantly in the *Nycticebinæ*, often in *Hapale*, and sometimes in *Simia*, *Colobus*, and *Cynocephalus*.

In *Lemur*, the transverse process being developed concomitantly with the antero-posteriorly extended neurapophyses, the vertebral artery may be said rather to traverse a bony canal than merely to pass through a foramen. This condition is still more marked in *Indris*.

The lowest part of the neurapophysis is, on each side, produced so as to embrace the posterior part of the body of the axis. In all the *Anthropoidea*, in *Lemur*, and in the *Nycticebinæ* these produced parts extend about as far forwards as do the anterior zygapophyses, sometimes a little beyond them (*e. g.* Chimpanzee, Orang, and *Ateles*), sometimes not quite so far forwards (e. g. *Lemur*); but in *Indris* we for the first time meet with anterior zygapophyses which extend much more forwards than do the roots of the neurapophyses.

The fourth Cervical Vertebra.—In none but Man, and not constantly in him, has this vertebra a decidedly bifurcated spinous process, though a trace of bifurcation is sometimes found in that of the Chimpanzee. In the Gorilla this process is exceedingly produced, being the absolutely longest neural spine attached to any vertebra of that or of any other species of the whole order.

In *Simia*, *Perodicticus*, and *Arctocebus* it is also very much prolonged. In *Hylobates* and all the lower *Simiidæ* it is shorter than that of the axis. In some of the *Cebidæ*, especially *Ateles* (fig. 6) and *Chrysothrix*, it is, like the spine of the third cervical vertebra, somewhat curved forwards.

In *Mycetes* (fig. 1) it is rather longer than in the other *Cebidæ*, and still shows an indication of that trifid character presented by the axis and third cervical vertebræ.

In the *Lemuroidea*, except *Perodicticus* and *Arctocebus*, it is, as already mentioned, short, and in *Loris*, *Tarsius*, *Galago*, and *Cheiromys* almost or quite obsolete.

The transverse process is always bifurcated at its extremity, except in *Lemur* and *Indris*. Even in *Lemur* there is a slight incipient bifurcation; but this is never the case in *Indris*.

The fifth Cervical Vertebra.—In Man alone is the spinous process of this vertebra ever distinctly bifurcated.

In none but *Indris* is its transverse process constantly without even a trace of bifurcation.

On the whole, this vertebra repeats the characters of the fourth cervical. Its spine* is generally as long as, or rather longer, rarely (*e. g.* sometimes in the Gorilla and Orang) it is somewhat shorter, than that of the fourth vertebra.

The transverse process has its upper and lower extremities rather more produced and separated than in the preceding vertebra, the bifurcation becoming thus deeper and more marked.

Occasionally in *Ateles* (fig. 6) and *Mycetes* the upper portion of

* In the skeleton of a young Chimpanzee in the British Museum (marked 2 *i*) the spinous processes of this and the following vertebra are quite anchylosed together, the neural laminæ remaining distinct.

the bifurcated transverse process itself more or less bifurcates, developing a small backwardly projecting secondary process, which is perhaps a nascent *anapophysis*.

The sixth Cervical Vertebra.—This very characteristic vertebra is in none but Man ever provided with a bifurcated spinous process, and it is often simple in him. It is very long in *Troglodytes* and *Simia*, also in *Perodicticus* and *Arctocebus*. In *Tarsius* it is rudimentary, and in *Galago* (fig. 8) and *Cheiromys* obsolete. In the other forms it is moderate, sometimes exceeding and sometimes falling short of the length of the spine of the axis.

The transverse process is subject to much individual variation as to the extent of development and the form of its pleurapophysial portion. It is mostly more extended than in Man, either transversely or antero-posteriorly, or both. Thus even in the Gorilla it is rather more antero-posteriorly, and much more transversely, produced than in him; it also diverges much more from the upper part (diapophysis of Professor Owen); but in the adult Chimpanzee it is very human in its proportions. In none above *Hylobates* does the antero-posterior extent of the costal element equal the antero-posterior length of the under surface of the centrum. In the *Simiidæ*, other than the *Simiinæ*, however, this element generally becomes much antero-posteriorly extended, exceeding the centrum in length. But sometimes it is only its outer border which is so expanded, the hinder margin being more or less deeply excavated, so that the costal parts take the form of two long processes, one springing from beneath each vertebral foramen, and the two running back parallel to each other, beneath the transverse processes of the seventh cervical vertebra. Amongst the *Cebidæ* there is considerable variation. Sometimes in *Ateles* (fig. 6), as also in *Nyctipithecus* and *Pithecia*, the costal part of this vertebra is scarcely larger than the corresponding part of the fifth vertebra; and the same is the case in *Loris*, *Perodicticus*, and *Arctocebus*. In *Lemur*, on the other hand, it is large, and exceeds the centrum in length.

In *Ateles* (fig. 6) and *Mycetes* the upper part of the transverse process, or diapophysis of Owen, often presents a distinct anapophysis.

In *Indris* the diapophysial process, which projects from above quite the anterior end of the costal element, so much resembles the entire transverse process of the more anterior vertebræ that the pleurapophysial part seems, in this genus, to make its appearance for the first time in this sixth vertebra. It depends from the outer side of the back part of the under surface of the centrum, and is very conspicuous.

In the Orang the transverse process is sometimes only grooved, instead of being perforated, by the vertebral artery.

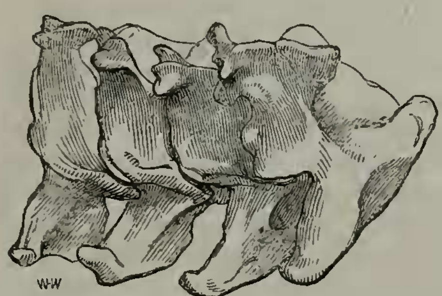
The seventh Cervical Vertebra.—The neural spine of this vertebra never bifurcates. Except in the Gorilla, the Orang, and the Aye-Aye, it is the longest, or equal to the longest, of the cervical spines posterior to the axis. It generally exceeds, but sometimes falls short of, the spine of the axis in length. In *Perodicticus* and *Arctocebus* it very considerably exceeds it; but in *Tarsius*, *Galago*, and *Cheiromys* it very greatly falls short of it, in the last-named the spine being here more completely absent than even in the third and fourth cervical vertebræ.

The neural laminæ repeat the characters of those of the preceding vertebræ, except in *Loris* and *Indris*. In the first of these genera this vertebra* has the neural laminæ more antero-posteriorly extended than have the other cervical vertebræ. In the second genus, *Indris*, the opposite condition obtains, the antero-posterior extent of the neural laminæ of this vertebra being distinctly less than that of the other and more anterior ones.

The transverse process varies much, as to its perforate or imperforate condition; but I have never seen it perforated in *Hylobates*, *Mycetes*, *Brachyurus*, *Nyctipithecus*, *Chrysothrix*, *Hapale*, *Lemur*, *Galago*, *Arctocebus*, and *Cheiromys*.

Thus we find that in the cervical vertebræ the spinous processes present their maximum of bifurcation in European Man, where that condition generally obtains from the second to the sixth vertebra inclusive. In no other genus besides, except *Nycticebus*, do we meet with a distinctly bifurcated spine to the third cervical vertebra; but a more or less trifid axis exists in *Troglodytes*, and a similar structure is distinctly marked in *Mycetes*, and repeated in the third and fourth vertebræ also (fig. 1). In most species of the order, as also

Fig. 1.



Axis and three following cervical vertebræ of *Mycetes*, from the Museum of the Royal College of Surgeons. Nat. size.

at least sometimes in certain races of Man, the cervical spines are simple and rather short, generally increasing gradually in length from the third to the seventh. Some of the *Cebidæ* (fig. 6) present us with a remarkable bending-over in a forward direction of the summits of their cervical spines. In *Indris* they are of a subequal height, and somewhat enlarged at the distal end. Some genera, e. g. *Tarsius*, *Cheiromys*, and *Galago* (fig. 8), are remarkable for the atrophy of these parts; while others, e. g. *Troglodytes*†, *Simia*, *Pe-*

* In no. 67 *a*, in the British Museum, the neural laminæ of the sixth and seventh cervical vertebræ are anchylosed together.

† In the skeleton of a young *T. niger* (no. 2 *i*), in the Osteological Collection of the British Museum, the spines of the fifth and sixth cervical vertebræ are completely anchylosed together, though the neurapophyses of the two vertebræ are distinct and separate.

rodicticus, and *Arctocebus*, are distinguished by their excess of development, the Gorilla exceeding all other mammals, even *Didelphys*, in the great preponderance of the cervical spines over those of the rest of the vertebral column.

The neural laminæ have in most *Anthropoidea* nearly the same proportions; but they are thickened in those forms which possess immense spinous processes; and in *Hylobates* and *Ateles* they are relatively more extended in the antero-posterior direction. This extension is yet greater in *Lemur*, where, at least sometimes, the length is more than half the breadth; and greatest in *Indris*, where it equals or exceeds two-thirds of the breadth, the elongated neurapophyses being medianly split behind in all the vertebræ from the second to the seventh.

In *Indris* also the anterior zygapophyses are much in advance of the most anterior part of the bases of the neurapophyses.

The whole series of neural laminæ in each individual are pretty equal, except in *Loris* and *Indris*, the seventh vertebra having its neural laminæ in the first of these two forms mostly larger, in the second smaller, than those of the preceding cervical vertebræ.

Beneath the anterior zygapophysis a more or less marked prominence often exists; it is to be seen in many forms, but is particularly conspicuous in the genera *Ateles* (fig. 6), *Perodicticus*, and *Arctocebus*. This prominence is the metapophysis.

The transverse processes have their extremities bifurcated in a varying number of the cervical vertebræ, and in a varying degree.

In none do they bifurcate so evenly and uniformly from the third to the sixth vertebræ as in Man, thus forming an even and equable groove on each side of the neck.

In all the *Anthropoidea*, except *Cynocephalus* and *Hapale*, this groove does not commence until the fourth vertebra; but in those two genera and in the *Nycticebinæ* it often begins at the third, sometimes in *Cynocephalus* even at the second. In *Lemur* this groove does not begin till the fifth vertebra; and in *Indris* it exists in the sixth vertebra only.

The ends of the diapophysial parts of the transverse processes are upcurved in the *Anthropoidea*. In the *Lemuroidea* the transverse process is bent more downwards and more directly backwards, and, being more extended antero-posteriorly, forms a longer bony canal for the vertebral artery.

The diapophysis, in the more posterior cervical vertebræ, often gives off a secondary backwardly directed process, which is perhaps a rudimentary anapophysis. This is particularly well seen in *Ateles** (fig. 6) and *Mycetes*.

The costal plate of the sixth cervical vertebra is almost always larger than the homologous part in the other cervicals; but it predominates least in Man, the Chimpanzee, *Nyctipithecus*, and the *Nycticebinæ*. In *Indris* it predominates more than in any other genus of the order.

The bodies of the vertebræ have their articulating surfaces more

* See no. 4695 in the Osteological Collection of the Royal College of Surgeons (Osteological Catalogue, vol. ii. p. 729).

or less oblique; but there is great, apparently even individual, variation in this respect. This character appears least marked in Man.

In *Lemur* the under surfaces of the second, third, and fourth vertebræ have often a marked median ridge, such as is found in no *Anthropoidea*. This is wanting in the Slow Lemurs, but is greatly developed in *Indris*, the posterior part of each centrum being produced so as to underlap the centrum next behind in a remarkable manner.

The breadth of each centrum (taking the third cervical vertebra as the standard of comparison) rarely exceeds its antero-posterior dimension so much as it does in Man. Yet it does so in *Nycticebus*, where the breadth is twice and a half the length.

In *Troglodytes* and *Simia* the length is already greater in proportion to the breadth than in Man; in *Hylobates* the two dimensions are nearly equal, as also in the other genera, if the length does not slightly exceed the breadth as it does in *Cynocephalus*, *Ateles*, and *Mycetes*. In *Lemur* and *Indris* the length exceeds once and a half the breadth.

Dorsal Vertebræ.

The number of dorsal or rib-bearing vertebræ varies from a minimum of 11 to a maximum of 16.

In Man and the *Simiadæ* there are generally 12 or 13, and rarely 14 or only 11 dorsal vertebræ.

In Man the number is normally 12, very rarely 13.

In the Gorilla it is, apparently, always 13.

In the Chimpanzee there are normally 13 dorsal vertebræ; but occasionally there are 14*, or only 12†.

In the Orang there are 12.

In *Hylobates* 12, 13, or rarely 14‡.

In *Semnopithecus* and *Colobus* 12.

In *Cercopithecus* 11, 12, or 13.

In *Macacus* 11 or 12, very rarely 13§.

In *Cynocephalus* 12 or 13.

In the *Cebidæ* the range is different, namely from 12‖ to 15, thus:—

In *Ateles* 13 or 14.

In *Lagothrix* 14.

In *Cebus* 13, 14, or rarely 12.

In *Mycetes* 13 or 14.

In *Pithecia*, *Brachyurus*, and *Chrysothrix* 13.

In *Nyctipithecus* from 13 to 15.

* Cuv. Leçons d'Anat. Comp. vol. i. p. 177.

† In a skeleton recently added to the Hunterian Collection (and to which Mr. W. H. Flower kindly directed my attention) there are but twelve dorsal vertebræ, and only the usual number of lumbar vertebræ, that answering to the fifth lumbar of Man forming part of its sacrum.

‡ No. 5029 in the Museum of the Royal College of Surgeons (Osteological Catalogue, vol. ii. p. 756).

§ Nos. 4860 and 4942 in the Collection of the Royal College of Surgeons (Osteological Catalogue, vol. ii. pp. 744 & 749).

‖ In one instance I have found only eleven—namely, in *Callithrix personatus* (no. 51*d* in the Osteological Collection of the British Museum).

In the *Hapalidæ* there are 12 or 13 dorsal vertebræ.
In the *Lemuridæ* the range is greater, namely, from 12 to 16.
Thus in *Lemur* the number is either 12 or 13.
in *Indris* it is 12, rarely 13.
in *Galago* and *Microcebus* 13.
in *Loris* and *Perodicticus* 14 or 15.
in *Arctocebus* 15.
in *Nycticebus* 16.
in the *Tarsiidæ* it is 13 or 14.
in the *Cheiromyidæ* 13.

The proportion of the dorsal to the other regions of the spinal column (exclusive of the caudal) does not increase regularly with the number of dorsal vertebræ, not being quite so great even in *Loris* as it is in Man. This region attains its greatest relative length in *Ateles*, where it is over nine-twentieths of the total length of the spine, without the tail; and it is least in *Indris*, where it scarcely exceeds six-twentieths of such total length. *Nyctipithecus*, even when possessing fifteen dorsal vertebræ, has a relatively shorter dorsal region than exists in *Homo*, *Troglodytes*, or *Simia*.

Neural Spines.—The more anterior are always the narrowest (*i. e.* least antero-posteriorly extended), and are generally more perpendicular and less overlapping than in Man.

The increase in antero-posterior extent, as we proceed from before backwards along the dorsal series of vertebræ, is already greater in the *Simiinæ* than in the *Hominidæ*, and becomes still more so in the lower forms.

The summits of the dorsal spines are sometimes expanded and flattened, as in *Cynocephalus*, *Macacus*, *Simia*, and *Troglodytes*, especially the Gorilla, the last four in which sometimes almost bifurcate; on the other hand, they are sometimes very antero-posteriorly extended near the apex, almost bifurcating in that direction in some*.

The inclination of the majority of the dorsal spines is always backwards. They are all so inclined in some of the lower races of Man, in the *Simiinæ* and *Nycticebinæ*, as also almost invariably in *Ateles*.

In the higher races of Man the spines of the eleventh and twelfth dorsal vertebræ are nearly at right angles to the long axis of the spine.

In *Indris* the spines are very little inclined, but the twelfth sometimes bends slightly forwards. In all the other forms the last dorsal spines are decidedly inclined anteriorly, the twelfth being always so, and sometimes in *Hapale* even the tenth.

The neural laminæ possess very similar proportions throughout the *Anthropoidea*. In *Lemur* they very little exceed those of the cervical vertebræ in length (*i. e.* in antero-posterior extent), only as six to five, and in *Indris* are actually (and for the first time) shorter, being as three to four. The opposite extreme is found in *Loris*, where the dorsal neural laminæ are double the length of those of the cervical vertebræ, except the seventh.

* This character is very marked in a skeleton of *C. albogularis* (no. 17 *b*) in the British Museum; and to a less degree in another individual of the same species (no. 17 *h*), also in the British Museum.

In *Galago* (fig. 8, *h*), *Lagothrix* (fig. 11, *h*), and *Mycetes* (fig. 2, *h*) there are certain extra and backwardly projecting processes, which are more conveniently to be described with the lumbar region, where they are more developed.

The transverse processes do not project so much upwards (*i. e.* dorsally) in any other genus as they do in Man. Therefore the longitudinal groove existing on each side of the series of spinous processes, and bounded externally by the series of ends of the transverse processes, is deepest in Man. The width of this groove continues from before backwards most equal in the *Nycticebinæ*, then in the *Simiinæ*, and then in Man, where it appears narrowed at its posterior (lower) part, owing to the great difference existing between the length of the transverse processes of the most anterior (upper) and that of those of the most posterior (lower) portions of the dorsal vertebræ.

In *Hylobates* the dorsal vertebral groove is slightly interrupted by an accessory process at the thirteenth vertebra. It is so also in *Nyctipithecus*; but in *Ateles* at the twelfth. In the other forms this interruption takes place at the eleventh, or even, as generally in the lower *Simiadæ* and *Hapale*, at the tenth vertebra. The distal ends of the dorsal transverse processes are often more or less enlarged antero-posteriorly, though the extent of this enlargement varies much. In the Gorilla it is considerably more marked than in Man; but often very much more so in *Hylobates*, and above all in *Ateles*. This expansion is due to the nascent metapophyses and anapophyses, which will be described later.

The increase in breadth (transverse diameter) of the bodies of the vertebræ, as we proceed from before backwards, is exceptionally great in Man, *Hylobates*, and *Cynocephalus*; it is considerably less in *Simia* and *Troglodytes*, and is at its minimum in the *Nycticebinæ*, as is also the increase in antero-posterior extent.

The spinal nerves pass out by notches in almost all species. In Man, *Nycticebus*, and *Loris* these notches are deeper than in the other forms; but in *Perodicticus* (fig. 12) and *Arctocebus* we meet with quite a peculiar condition, namely the direct perforation of the neurapophyses in all the dorsal vertebræ. This foramen is situated behind the capitular and beneath the tubercular process. In *Arctocebus* another, smaller perforation, running from before backwards, pierces the root of the transverse process in each dorsal vertebra, except the first and the thirteenth.

Lumbar Vertebræ.

The lumbar region varies considerably both as to the number of its component vertebræ and as to its relative extent compared to that of the other regions of the spine.

The greatest number is presented by *Loris* and *Indris*, viz. 9; the least in *Troglodytes*, where there are sometimes only three. In Man, the Orang, and Gibbons* there are normally 5; in *Ateles* sometimes 5, though more generally 4; in *Lagothrix* 4. In all the other

* Daubenton records six (see Buffon's Hist. Nat. t. xiv. p. 104).

genera there are 6 or 7 lumbar-vertebræ*, except *Cebus*, which has sometimes as few as 5, and *Nycticebus* and *Perodicticus*, which have often as many as 8.

The lumbar region attains its greatest length in proportion to the other regions of the spine, exclusive of the tail, in *Nyctipithecus*, *Chrysothrix*, *Colobus*, *Semnopithecus*, *Cynocephalus*, and *Loris*. It is least in the Gibbons, Man, *Ateles*, *Simia*, and *Troglodytes*. The last two genera, with *Perodicticus* and *Arctocebus*, are remarkable for the very slight increase in size of the lumbar series of vertebræ from before backwards.

These vertebræ have their length and breadth about equal in the *Nycticebinæ* and *Tarsius*; in Man, *Troglodytes*, and *Simia*, breadth is in excess, while length is so in most of the other forms. The length of the individual lumbar vertebræ compared to the dorsal (selecting the ninth dorsal and longest lumbar for comparison in each species) is greatest in the lower *Cebidæ* (more than double in *Nyctipithecus*, *Chrysothrix*, and *Brachyurus*), rather less in the lower *Simiidæ* and *Lemurinæ*, still less in the *Simiinæ* and *Nycticebinæ*, and least in Man.

The number of dorsal and lumbar vertebræ, taken together, is greatest in *Loris* and *Nycticebus* (23 or 24); small in Man, *Troglodytes*, and *Simia* (17), and *Ateles* and *Hylobates* (mostly 18). In the other *Simiadæ* there are almost invariably 19 trunk vertebræ†.

The proportion borne by the lumbar to the dorsal region is greatest in *Indris*, then in *Nyctipithecus*, *Chrysothrix*, and some *Simiadæ* (e. g. *Colobus*). In most forms the two regions are about equal; but the lumbar is the shorter in Man, the Gibbons, and Orang, *Ateles*, and *Troglodytes*, in the Gorilla being less than half the dorsal region in length. The beautiful sigmoid curve formed by the dorsal and lumbar vertebræ of Man exists in no other species; but the nearest approximation to it is found not in the highest Apes, but in *Cynocephalus*‡.

The neural spines are all vertical, or project more or less backwards, in Man, the *Simiinæ*, *Ateles*, and in the *Nycticebinæ*; in some of the lowest *Simiidæ* some of them are also more or less vertical. In *Indris* the spine of the first lumbar vertebra is inclined slightly forwards. All the lumbar spines project forwards in the other forms, especially in the lower *Cebidæ*, in *Hapale*, and in *Lemur*, in all of which they are very long, and arch over the vertebra next in front in a very marked way. In *Galago* (fig. 8, *h*) a process projects backwards on each side of each lumbar vertebra, above the posterior zygapophysis, the two of each vertebra closely embracing the forwardly

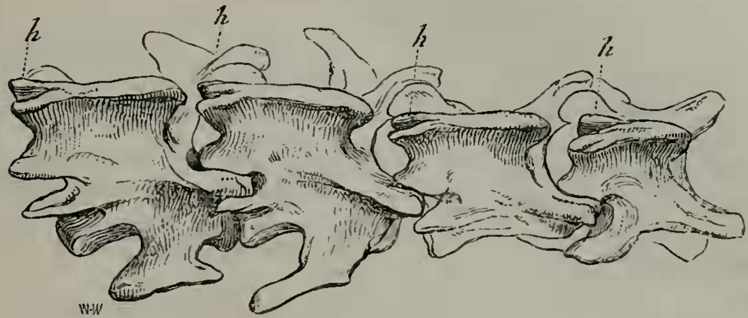
* De Blainville mentions a Baboon in the Paris collection with eight lumbar and twelve dorsal vertebræ (Ostéog. Primates, *Pithecus*, p. 40).

† In a *Macacus radiatus*, in the British Museum (no. 1103 *c*), the vertebræ are 12 d.+6 l.=18; in a *Cynocephalus babouin* (no. 36 *c* in the same collection) the number is 13 d.+7 l.=20. De Blainville mentions 12 d.+8 l.=20. See Ostéog. Primates, *Pithecus*, p. 40, above referred to.

‡ E. g. *Cynocephalus porcarius* (no. 35 *d* in the Osteological Collection of the British Museum), which is a *natural* skeleton, having all the ligaments, intervertebral cartilages, &c. See also the Mandril, no. 4719 in the Osteological Collection of the Royal College of Surgeons.

projecting spine of the vertebra next behind. Rudiments of these processes exist in the posterior dorsal vertebræ, as has been mentioned. In *Mycetes* (which has some of the cervical spines trifid) these extra

Fig. 2.



Last two dorsal and first two lumbar vertebræ of *Mycetes*, from the Museum of the Royal College of Surgeons. Nat. size. *h*. Hyperapophysis.

processes are also developed in certain of the lumbar vertebræ, as also in *Lagothrix* (fig. 11, *h*), and sometimes in *Hapale** and *Chrysothrix*.

The neural laminæ are much less relatively extended, in the antero-posterior direction, in Man, the *Simiinæ*, and *Ateles* than they are in the other *Anthropoidea*. In *Lemur* their length is not so preponderating, because of the elongation of the cervical neurapophyses. In *Indris* they are exceptional, inasmuch as they are scarcely, if at all, longer than are the neural laminæ of the cervical vertebræ of that genus; as is always the case, however, they are longer than the dorsal neurapophyses.

The Transverse Processes.—These processes always project outwards, more or less at right angles to the long axis of the spine, or else forwards†. In Man, the *Simiinæ*, and *Ateles* they are never inclined ventrally; but in some of the lower *Simiidæ* they begin to be so; in the lower *Cebidæ*, in *Hapale*, and *Lemur* they are so very decidedly. In the *Nycticebinæ* and *Indris* they are nearly horizontal; but only in Man, *Troglodytes*‡, and *Simia* do they incline somewhat upwards.

They spring from a higher point, with regard to the centrum, in Man than in any other Primate; *Troglodytes* in this respect approaches him the most, and then *Simia*,—*Hylobates*, in spite of the relative length of the legs to the spine, being much less like Man in this respect; and the same must be said of the long-legged *Indris*.

* As in *H. midas* (no. 1889 *a* in the Osteological Collection of the British Museum) and *H. œdipus* (no. 53 *a* in the same collection).

† In those cases where they project strongly backwards, a rib is anchylosed and included, as in the skeleton of a Chimpanzee in the Museum of the Royal College of Surgeons, obtained from M. du Chaillu, and in skeletons of *Mycetes seniculus* and of *Semnopithecus nasalis* in the British Museum.

‡ In a specimen of *T. niger* (nos. 2 *c*, 4, 6, 10, 33, 11) in the British Museum the first lumbar vertebra has a distinctly double, though very small, transverse process on each side.

The lumbar transverse process has sometimes its distal end antero-posteriorly expanded*; and sometimes a process is developed from its posterior margin similar in form and direction to the anapophysis, but external to it, as in *Cheiromys*† and often in *Lemur*. In the last-mentioned genus there is generally a second posterior transverse process to each lumbar vertebra; it projects from the posterior part of the side of the centrum, and appears to be serially homologous with that part of the centrum of a dorsal vertebra which articulates with the anterior part of the head of the rib. A trace of this process exists in *Indris*.

The metapophyses and anapophyses are always, except in *Tarsius*, most conspicuous in the lumbar region. They are exceptionally rudimentary in Man, *Troglodytes*, and *Simia*. But the condition of these processes will be more fully described later.

Sacrum.

This region attains its greatest relative length in the Gorilla; but in the Chimpanzee, the Orang, and the Gibbons it is longer relatively than in Man, *i. e.* longer compared to the total length of the cervical, dorsal, and lumbar vertebræ. It is shortest in the lower *Simiidæ* and true Lemurs. Of all the *Anthropoidea* below *Hylobates*, *Ateles* has considerably the longest sacrum relatively.

The human sacrum is remarkable for the coexistence of certain characters, such as the very marked sacro-vertebral angle formed by it, the transverse and antero-posterior (vertical) concavity of its anterior surface, the concurrence of as many as five or six vertebræ in its formation (three of them generally contributing to form the auricular surface), its great breadth and the gradual way in which it narrows posteriorly (below) without any sudden contraction, the large size of the foramina, and the small development of the spinous and other processes. Each of these characters, taken separately, is shared by some other form or forms of the order. Thus, as to the number of sacral vertebræ (a character which varies more or less with age), all the *Simiinæ* have almost always five at the least; but in *Troglodytes* and *Simia* there are always five, without counting the last lumbar vertebra, which commonly anchyloses with the sacrum; while in *Hylobates* there are rarely more than five‡ in all, the first of these being probably in all cases the vertebra which answers to the last lumbar of Man. In all the other *Anthropoidea* there are generally only two or three sacral vertebræ—rarely four, as sometimes in *Cynocephalus*, *Ateles*, and *Brachyurus*. In the *Lemuroidea* two or three is still the normal number; but in *Indris* there are four, and in *Perodicticus* and *Arctocebus* five. In the *Simiinæ* three vertebræ § articulate with the ilium, as mostly in Man; but then the upper one of

* E. g. *Inuus* in British Museum, no. 32 *d*.

† See Prof. Owen's Memoir on *Cheiromys*, Trans. Zool. Soc. vol. v. pl. xxi. figs. 7, 8.

‡ De Blainville mentions seven sacral vertebræ (Ostéog. Primates, *Pithecus*, p. 24).

§ De Blainville, *l. c.* p. 25.

the three is the homologue of the Human last lumbar vertebra*. In all the rest of the order, but one or two vertebræ articulate with the ilium, except sometimes in *Ateles* and in *Indris*, when three again share in that office.

The Sacro-vertebral Angle.—In most Primates the sacrum and lumbar vertebræ appear (as far as one can judge from skeletons alone) to lie almost, or quite, in one line, so that the promontory is very slightly marked. *Troglodytes* presents in this respect a great contrast to the Human structure. In *Simia* the sacro-vertebral angle is rather more marked; but sometimes in *Cynocephalus* it is so much so as almost to rival that of Man†.

The same may be said of the concavity of the anterior surface of the sacrum, though this is subject to great individual variation. It is most marked in Man and the *Cynocephali*‡; and is more so in *Simia*§ than in *Troglodytes*.

The foramina vary greatly as to their relative size; but they appear to be generally small in *Troglodytes* and *Cynocephalus*, and especially large in Man, *Simia*, *Ateles*, and *Indris*.

The sacrum gradually tapers posteriorly in *Troglodytes* and *Simia*, and more or less in *Hylobates*, also in the *Nycticebinæ* and in *Indris*, as well as in Man; but in very many forms of the order it is very wide at its anterior end (the transverse processes standing out like a pair of expanded wings), and then suddenly contracts, so that the transverse diameter of the third sacral vertebra is very much smaller than that of the first. This is especially the case in the *Semnopithecinæ* and *Cynopithecinæ*; in the *Cebidæ* generally, especially in *Ateles*, the contraction is not so marked; and in some, as also in many *Lemuroidea*, the transverse processes of the last sacral expand so as much more nearly to equal those of the first sacral vertebra in breadth.

On account of these wing-like transverse processes, the breadth of the sacrum, in the *Semnopithecinæ* and *Cynopithecinæ*, generally exceeds its length.

In *Troglodytes*, *Simia*, and *Indris*, and still more in the *Nycticebinæ*, the length exceeds the breadth.

In the other genera these dimensions are generally more or less subequal.

The spinous processes of the sacrum tend generally, with age, to run together and form a ridge. They are relatively least developed in Man, *Simia*, and *Nycticebus*. They are relatively larger in *Loris*, *Tarsius*, and *Indris*, attaining their maximum in *Lagothrix*‖.

* Prof. Owen remarks that in a young Chimpanzee four vertebræ articulate with the ilia. See Osteological Catalogue, vol. ii. p. 781, no. 5173.

† See the skeleton of a Mandril (no. 4719) in the Museum of the Royal College of Surgeons; also *Cynocephalus porcarius* (no. 35 *d*) in the British Museum.

‡ It is strongly marked in *Macacus speciosus* (no. 1083 *a* in the British Museum); and in *Cynocephalus porcarius* (no. 35 *d* in the same collection) the transverse concavity of the sacrum is quite as great as in Man.

§ Yet in the skeleton (nos. 43, 10, 2, 1) in the Osteological Collection of the British Museum the anterior surface of the sacrum is quite flat. In nos. 45, 10, 2, 2, 3 *c*, in the same collection the sacrum, on the other hand, is as concave antero-posteriorly and transversely as in Man.

‖ See the skeleton (no. A. 4718 *a*) in Museum of the Royal College of Surgeons.

The metapophyses are generally more developed and more distinct than in Man; but in *Simia, Indris,* and most of the *Nycticebinæ* they are very inconspicuous.

Except in Man, the sacrum generally bears at its posterior end the lateral diverging processes (termed diapophyses* by Prof. Owen): they are very slightly marked in *Hylobates* and the *Nycticebinæ*; but in most of the genera they are strongly so, especially in *Cynocephalus* and *Ateles*. It appears to me not improbable that these processes may include, if they do not even represent, anapophyses.

The neural laminæ of the sacral vertebræ always form complete neural arches, except in the *Hominidæ* and *Simiinæ*, in which that of the last sacral is very often incomplete, and sometimes even those of the last two sacral vertebræ.

Caudal Vertebræ.

In the great majority of species of the order these vertebræ are numerous. Only in *Homo, Inuus,* and the *Simiinæ* is the number ever reduced to 3† or even to 4. In some of these, however, there are sometimes 5, and very rarely even 6‡, caudal vertebræ.

Then follow the *Nycticebinæ, Loris,* and *Nycticebus,* having sometimes as few as 5 or 6 caudal vertebræ, though the latter has sometimes as many as 7 or 8, which is about the number possessed by the very short-tailed *Cynocephali,* although, according to Cuvier§, the Mandril has sometimes only 5. Then comes *Indris,* which has from 9 to 14‖, closely followed by the short-tailed Macaques and American *Brachyuri*—*e. g.* in *Macacus rhesus* 15, in *M. nemestrinus* and in *Brachyurus* 17—the shortness of the tail being occasioned rather by a diminution in size of the component vertebræ than by a decrease in their number.

In all the other forms the number ranges between 20 and 33, but sometimes with much variation in the same genus, as in *Hapale* 25 to 31, as also in *Semnopithecus,* this being the highest number in any of the *Simiidæ*; the greatest number in the whole order is found in *Ateles,* namely 33. Amongst the *Lemuroidea* such high numbers are not attained, *Lemur* having 29 at most, while *Galago* and *Cheiromys* have about 22 or 23.

The proportion borne by this region of the spine to all the more anterior part is greatest in *Ateles,* almost 3 to 1; in the other longest-tailed genera it is rarely so large as 2 to 1.

The absolute length of the tail is greatest in *Semnopithecus* and *Colobus,* in which genera the individual vertebræ attain their greatest length, namely, sometimes as much as 1·9 inch.

* *E. g.* in Trans. Zool. Soc. vol. iv. p. 107.

† De Blainville says of *Inuus,* "*deux coccygiennes*" (Ostéog. Primates, p. 39). The only case in which I have met with but two distinct caudal vertebræ is *Inuus,* no. 32 *d* in British Museum; and there the second is evidently composed of two anchylosed together.

‡ See skeleton of *Troglodytes niger* in British Museum (nos. 2 *h*, 48, 11, 20, 5).

§ Leçons d'Anat. Comp. vol. i. p. 178.

‖ In the skeleton in the British Museum there are fourteen caudal vertebræ.

The caudal vertebræ generally increase in length as we proceed backwards from the sacrum, till about the 7th, 8th, or 9th, which, with the 10th and 11th, are the longest caudal vertebræ in most long-tailed forms. In *Ateles*, however, it is the 11th, 12th, 13th, and 14th vertebræ which are the longest. But while in the long-tailed *Simiidæ** the increase begins to be decidedly marked at the third caudal; in the *Cebidæ* and long-tailed *Lemuroidea* the increase is not so rapid, the three first caudals being always short, and the fourth caudal vertebra the first to present a marked elongation. In the *Hapalidæ* the third caudal vertebra is sometimes decidedly longer than is the second.

In Man, the *Simiinæ*, the *Nycticebinæ*, *Inuus* (fig. 10), and *Indris* the caudal vertebræ decrease in length as we proceed backwards, constituting a more or less prolonged coccyx.

In Man and the *Simiinæ* the neural laminæ never or very rarely form a closed canal, nor do those of all the first four caudal vertebræ do so in *Inuus* and *Indris*; but in the other groups the first four caudal vertebræ always possess a complete neural arch. Sometimes in *Semnopithecus*, *Cebus*, &c., six are so formed; but in *Ateles* alone are there as many as eight caudal vertebræ, each provided with such a structure.

Neural spines are often developed on the first two or three caudal vertebræ in the long-tailed *Simiidæ*, on the first five in *Lagothrix*, and even on six in *Ateles*, but only on the first three or four of the other *Cebidæ*, and apparently on not more than three in the other genera of the order.

In all the long-tailed *Simiidæ* and *Cebidæ*, except *Inuus*, the first four caudals are united together by distinctly articulating zygapophyses. Sometimes in *Inuus* the second caudal vertebra has its posterior zygapophyses so little developed that they fail to attain the anterior zygapophyses of the third caudal vertebra; but in the other *Semnopithecinæ* and *Cynopithecinæ* this failure first occurs in the fourth or fifth vertebra; in the *Cebidæ* generally, and in *Hapale*, not till the fifth or sixth; in *Lemur* and *Tarsius* at about the fifth; in *Mycetes* and *Lagothrix* at the sixth or seventh; but in *Ateles* alone not till the eighth.

In Man and the *Simiinæ* these processes are absent or quite rudimentary; the same is the case as regards the metapophyses, which are scarcely more distinct in *Inuus*, the short-tailed *Cynocephali*, and *Indris*. In all the long-tailed forms they are more or less prominent, retaining their distinctness from the anterior zygapophyses longest in *Ateles*—namely, till the ninth caudal vertebra.

The transverse processes of the caudal vertebræ are peculiar and interesting. At first they are undivided, and project more or less

* In a *Macacus nemestrinus* in the British Museum the first four caudal vertebræ are quite short, the fifth longer, and the sixth and seventh about the longest. Also in *Macacus speciosus* (no. 1083 *a* in British Museum) the third caudal is scarcely, if at all, longer than the second, yet the fourth is longer than the third; so that although there are only ten caudal vertebræ, they *do* increase in length backwards, thus differing from *Inuus*.

backwardly; but in the middle and posterior parts of the caudal region we find, in nearly all long-tailed forms, two nearly equal-sized transverse processes on each side, one projecting from the anterior part, and the other from the posterior part of each side of each centrum.

It would be well if we could certainly determine to what parts of the dorsal and lumbar vertebræ these caudal processes correspond.

If we were to examine the skeleton of *Lemur* only, we might consider that each posterior caudal transverse process corresponds with the peculiar posterior lumbar transverse process existing in that genus, and therefore also, as already indicated, with that part in each dorsal vertebra which articulates with the anterior part of the head of each rib.

On the other hand, a consideration of such forms as *Pithecia** and *Brachyurus*† shows how, in many cases at least, the anapophysis, which is distinct in the penultimate lumbar vertebra, comes in the ultimate one to unite again with the true transverse process, and to form the posterior part of its proximal portion, so that we might regard the anterior part of each divided caudal transverse process as answering to the true normal lumbar transverse process, and the posterior part of each divided caudal transverse process as answering to the lumbar anapophysis, here once more reappearing as a distinct element. Nor would this view be irreconcileable with the interpretation derived from *Lemur*, as in that genus the peculiar extra lumbar transverse process appears to coalesce with the anapophysis, so that we might consider the posterior caudal transverse process equivalent both to the anapophysis and to the Lemurine extra process at one and the same time.

The interpretation of the anterior caudal transverse process as the serial homologue of the true lumbar transverse process, and of the posterior caudal transverse process as an anapophysis is rather strengthened by the examination of the skeleton of *Hydromys chrysogaster*‡, in which the transverse processes of the anterior caudal vertebræ are quite similar in form, size, and direction to the more posterior lumbar transverse processes, with which evidently they are completely homologous (no anapophysis existing in either§); while the middle and posterior caudal vertebræ have the transverse process much enlarged antero-posteriorly, the added and backwardly projecting part apparently representing the anapophysis of the middle trunk vertebræ. Again in the Pangolin||, where anapophyses are entirely absent in the vertebræ of the trunk, the caudal vertebræ are simple and undivided, not projecting backwardly or developing any part answering to the posterior caudal transverse process found in long-tailed Primates. I am disposed therefore to regard the anterior

* See skeleton in the Museum of the Royal College of Surgeons.

† See skeleton in the British Museum (no. 806 *b*).

‡ See skeleton (no. 2243) in the Museum of the Royal College of Surgeons.

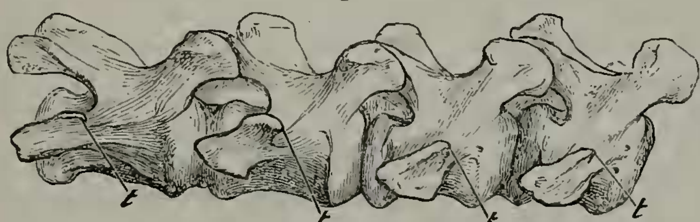
§ Owen remarks, "The anapophysis is obliterated in the last four lumbar vertebræ" (Osteological Catalogue, vol. ii. p. 401).

|| See skeleton (no. 2363 A) in the Museum of the Royal College of Surgeons.

transverse process of each caudal vertebra of a long-tailed Primate as answering to the ordinary transverse process of the lumbar vertebra, and the posterior transverse process of such a vertebra as answering to, and consisting of, a modified anapophysis.

A more or less distinctly marked process is often developed from the anterior part of the transverse process of the anterior caudal vertebræ—from those, in fact, or some of them, in which the bifurcation which we meet with as we proceed backwards has not yet taken place.

Fig. 3.



Four caudal vertebræ of *Ateles*, from the Museum of the Royal College of Surgeons (no. 4698). Nat. size. *t.* " Tubercles analagous to metapophyses."

These are spoken of by Professor Owen* as " tubercles analogous to metapophyses, and representing a second series of those processes," and are very well seen in the caudal vertebræ of *Ateles paniscus*, preparation no. 4698 in the Museum of the Royal College of Surgeons (fig. 3).

The lumbar true transverse process, as we have seen, sometimes bifurcates more or less at its distal end ; and this tendency to division of that part of the caudal transverse process which answers to such true lumbar transverse process is, perhaps, a similar bifurcation.

In Man and the *Simiinæ* the whole caudal transverse process is very obscurely represented, and is in a very rudimentary condition. In *Inuus* (fig. 10) it is strongly and largely developed, yet shows no tendency to divide into an anterior and a posterior portion; neither does it do so in the short-tailed *Cynocephali* or in *Macacus nemestrinus*. In all the long-tailed *Simiadæ*, however, the transverse process (which, as has been said, is at first simple) is given off from about the middle of the first two vertebræ ; but in those behind, which have the transverse process still undivided, it arises from nearer the posterior end of each vertebra. An indication of the division into anterior and posterior caudal transverse processes appears in the transverse process of the fourth or fifth vertebra, and about the sixth the division is complete, the two parts, which may perhaps be spoken of as the true transverse and the anapophysial caudal processes, being about equal in size.

In the *Cebidæ* this separation and equality is not so early attained, taking place in *Cebus* at about the seventh caudal vertebra, but in *Ateles* not till the ninth.

In most long-tailed forms the transverse processes of the first

* Osteological Catalogue, vol. ii. p. 730.

three or four caudal vertebræ stand strongly out, but in *Ateles* those of all the first six do so.

Chrysothrix is an exception, and differs from all other long-tailed genera in that the caudal transverse processes do not divide into two separate parts, but, remaining united, form an elongated plate-like process on each side of each vertebra almost throughout the caudal region, giving a quite peculiar aspect to the skeleton of the tail in that genus.

Caudal hæmapophyses and hypapophyses (that is, "chevron" or "Y-shaped" bones, or their rudiments, and processes for the attachment of such) are quite wanting in Man, the *Simiinæ*, *Inuus*, the *Nycticebinæ*, and *Indris*. They are more or less developed in all the other forms, attaining, as might be expected, their maximum in *Ateles*, where they present almost every variety of development in one or other part of the caudal region. At the root of the tail they are represented by long and completely detached Y-shaped bones, the two branches of the Y being attached to two scarcely perceptible processes (hypapophyses) developed from the anterior end of each centrum; these processes become more and more developed as we proceed backwards, the Y-shaped bones, however, continuing to be distinct till about the eighth or ninth caudal vertebra, where they are completely anchylosed to the vertebral processes. At about the tenth vertebra, and thence backwards, the processes are still completely anchylosed. They are, however, no longer Y-shaped*, but bifurcating and open inferiorly. The processes in question are, in this genus, the longest of any which arise from the posterior caudal vertebræ, and they continue to be developed throughout the series.

In the *Semnopithecinæ*, *Cynopithecinæ*, and *Cebidæ*, except *Ateles* and perhaps *Lagothrix*, these processes are less developed. In the *Simiidæ*, they appear to be most so in the genus *Macacus*. They exist throughout *Cynocephalus*, there being, even in the Mandril, bifurcated inferior processes in the mid-caudal region.

Very often in both *Anthropoidea* and *Lemuroidea* these parts exist in the form of pairs of little bones moveably articulated to the bodies of the vertebræ, and quite disunited in the middle line.

Sternum.

In most genera of the order, the sternum in the adult consists of a more or less enlarged manubrium, followed by a chain of subequal and antero-posteriorly elongated bones from three to six in number.

In Man and some of the *Simiinæ* alone do we find a sternum in the adult consisting of a manubrium followed by one bone only, such being the case in the Siamang, the Lar, variegated and perhaps other Gibbons.

In Man and the *Simiinæ* the sternum is broader, in proportion to its length, than in any other form; and this relative breadth attains its maximum not in Man, but in the Siamang (*Hylobates syndactylus*).

* Sometimes, however, Y-shaped bones reappear posterior to open and bifurcating hypapophyses.

The Ape which appears to approach Man most closely in the proportions of its sternum is *Hylobates lar* *.

In *Troglodytes* the body of the sternum remains, in the adult, more or less divided—sometimes, as in the skeleton of the large Gorilla in the British Museum, the manubrium anchylosing with the first bone of the body of the sternum, while its posterior component bones remain still distinct. The sternum of *T. gorilla* is much broader than that of *T. niger*.

In *Simia* the body of the sternum is at first divided in a singular but varying manner, which is well known, and has been often noticed †.

The manubrium has its anterior margin greatly thickened in *Simia*, Man, *Cynocephalus*, and the Siamang.

In *Indris* its anterior margin is prolonged downwards in a peculiar manner. In *Lemur* this part is sometimes narrow, pointed, and produced ‡.

In *Chrysothrix* the manubrium has a strong process standing out on each side, and serving for the attachment of the first rib.

In a specimen of *Mycetes* preserved in the British Museum (no. 44 *a*) the manubrium is completely divided in the middle line,

Fig. 4.

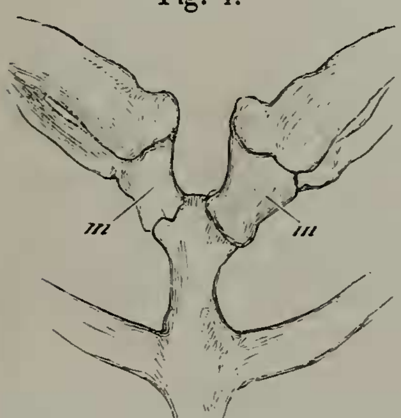
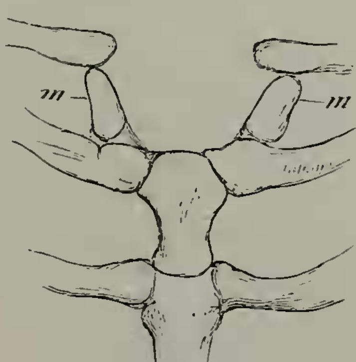


Fig. 5.



Anterior part of sternum of *Mycetes*. Nat. size. *m*. Divided manubrium.
Fig. 4. Specimen in the British Museum.
5. Specimen in the Museum of the Royal College of Surgeons.

each half supporting a clavicle and first rib §. It is also completely divided in the specimen in the Museum of the College of Surgeons.

* No. 5027 in the Museum of the Royal College of Surgeons.

† Owen, Trans. Zool. Soc. vol. i. p. 363, and Osteological Catalogue, vol. ii. pp. 763 & 765, nos. 5058 & 5071; Vrolik, Recherches d'Anat. Comp. sur le Chimpansé, p. 11; De Blainville, Ostéog. Primates, *Pithecus*, i. p. 30.

‡ *E.g.* in no. 5027 in the Museum of the Royal College of Surgeons. Vrolik says (*l. c.* p. 12) that in the Mongous the manubrium quite disappears. I have not observed this.

§ De Blainville says, "Le manubrium paraît plus profondément bifurqué en avant que chez les autres Sapajous" (l. c. *Cebus*, p. 16).

In *Galago* the manubrium is somewhat T-shaped, as in the skeleton of *G. allenii* in the British Museum.

The number of distinct bones posterior to the manubrium and anterior to the xiphoid cartilage varies, in the Primates below the *Simiinæ*, from four to six, except in *Nycticebus*.

As to the number found in each genus, it is subject to some variation. Thus in *Semnopithecus* and *Colobus* there are generally four in adults*, but sometimes five; in *Cercopithecus* almost always five, but rarely there are six even in adults†; in *Macacus* and *Cynocephalus* five or six; in *Ateles* six, but in *Cebus* generally five, and in the other *Cebidæ* and in *Hapale* four or five; the same in *Galago, Indris,* and *Lemur*, but in *Loris* and *Perodicticus* as many as six. In *Nycticebus* alone have I seen more than this, namely, as many as nine; but this was in an immature specimen.

Ribs.

Almost all Primates have more true than false ribs. In the highest forms the number of pairs of true ribs is seven, but in *Hylobates* there are sometimes eight pairs. In *Semnopithecus* and *Colobus* there are generally seven, but sometimes eight pairs of true ribs. In the *Cynopithecinæ* the normal number is eight. In the *Cebidæ* there are generally seven or eight pairs, but in *Ateles* sometimes nine. In *Hapale* there are sometimes as few as six, sometimes as many as eight; seven or eight in *Galago, Lemur*, and *Indris*; nine in *Cheiromys*. The highest number, as might be expected, is found in the *Nycticebinæ*, there being as many as ten pairs of true ribs in *Perodicticus*‡ and *Loris*§.

The total number of pairs of ribs is not always constant in the same species, there being in Man sometimes thirteen, sometimes only eleven pairs; in the Chimpanzee sometimes only twelve, and so on.

The ribs of Man are distinguished from those of the other genera of the order by their more marked "angles," and by the greater arching backwards of their proximal parts. In these respects the Gibbons approach most nearly to Man.

The remarkable sigmoid twist in a vertical direction, which exists in the ribs of Man, exists also markedly, though in a less degree, in *Troglodytes*. In *Simia* and the lower Primates it is much less noticeable.

Pithecia‖ is distinguished from all the rest of the order by the great relative breadth of the ribs. They are also wide, but to a less extent, in *Hapale midas*.

In Man the ribs form a thorax which in its shape and proportions differs from that of all other forms of the order, it being half as broad again as it is vertically (*i. e.* from back to breast) deep.

* In an adult *Colobus satanas* in the British Museum (no. 1180 *a*) there are five.

† *E. g.* in *C. ruber* (no. 15 *g*) in the British Museum.

‡ No. 743 *c* in the British Museum.

§ No. 4632 in the Museum of the Royal College of Surgeons. Noticed by Prof. Owen, 'Osteological Catalogue,' vol. ii. p. 718.

‖ See the skeleton of this genus in the Museum of the Royal College of Surgeons.

In all the *Simiinæ* the transverse diameter is still considerably in excess, exceeding the vertical depth by from about one-fourth to a little under one-third of the latter.

In *Indris* the transverse diameter is also decidedly in excess, though to a less degree, and it is so also in *Ateles* and even somewhat in *Mycetes*; but in all the other genera the vertical depth equals, or more or less decidedly exceeds, the transverse diameter of the thorax.

Having now reviewed the different regions of the spine, we may consider certain parts not as confined to those regions, but as extending throughout the vertebral column; and, first, the

Neural Spines.

These processes attain both their greatest absolute and relative length in *Troglodytes* and *Simia*, but above all in the Gorilla.

On the other hand, they are wanting in all caudal vertebræ* but a very few, and also in some of the cervical vertebræ of *Galago* and *Cheiromys*.

Generally it is the seventh cervical and most anterior dorsal vertebræ which bear the most elongated spines; but, besides *Troglodytes* and *Simia*, *Perodicticus* and *Arctocebus* form exceptions, and *Tarsius* also, in which the longest neural spines are sacral, or in the most posterior part of the lumbar region.

The spines of the trunk vertebræ are vertical, or directed backwards, in Man, the *Simiinæ*, *Ateles*, and the *Nycticebinæ*; but in all the other genera of the order the spines of the more posterior vertebræ are inclined forwards, the change of inclination taking place sometimes (e. g. *Hapale*) at the tenth, sometimes (e. g. *Cheiromys*) not till the thirteenth vertebra.

The amount of inclination of the spines of the posterior trunk vertebræ reaches its maximum in the lower *Cebidæ*, in *Hapale*, and in *Lemur*.

The summits of the spinous processes are often more or less flattened. This is generally very marked in the lumbar vertebræ of *Troglodytes* and *Simia*, also in *Macacus*, *Inuus*, and *Cynocephalus*, and to a less degree in *Hylobates*, *Ateles*, *Indris*, and others.

In all forms the antero-posterior extent of the spinous processes of the anterior region of the trunk is less than in those of the more posterior portion; but this increase is least in Man and the *Simiinæ*: in all the rest (the *Nycticebinæ* in this forming no exception) it is much greater.

Occasionally the antero-posterior extent of the summit considerably exceeds that of the part below, so that the spinous process may almost be said to bifurcate antero-posteriorly†.

* In *Ateles* the first five caudal vertebræ support spinous processes; and sometimes even the sixth does so.

† This is well seen in the dorsal vertebræ of *Cercopithecus albogularis* (no. 17 *b*) in the Osteological Collection of the British Museum, and to a less degree in another individual (no. 17 *h*) in the same collection, as has already been mentioned.

In the greater number of vertebræ in all species, and in all the vertebræ of the greater number of species, the spinous processes are simple, ending sometimes sharply, sometimes with a blunt termination. In certain vertebræ, however, there are two more or less distinct processes (when the spinous process is said to bifurcate); more rarely (fig. 1) there are three such projections (when the spinous process is spoken of as trifid).

The first condition is very often seen in the axis vertebra, especially in Man, *Simia, Hylobates, Ateles, Hapale,* and the *Nycticebinæ.* It is rarely found in the third cervical vertebra; it is so in European Man and *Nycticebus,* and in the fourth and fifth cervical vertebræ of European Man. An imperfect bifurcation also exists sometimes in the most posterior dorsal or in some of the lumbar vertebræ, as occasionally in Man and in *Troglodytes.*

The second condition, or trifid spinous process, exists in the axis and in one or more of the succeeding cervical vertebræ of *Mycetes* (fig. 1); also to a greater or less extent in the axis of the Chimpanzee.

The peculiar processes which have been mentioned as existing in the lumbar vertebræ of *Galago* (fig. 8, *h*), *Lagothrix* (fig. 11, *h*), and *Mycetes* (fig. 2, *h*) appear to be serially homologous with the two lateral portions of the trifid spinous process.

Neural Laminæ.

The neural laminæ always form a complete arch, except in the greater part (or, as in Man, the whole) of the caudal (coccygeal) region, and sometimes, as in him and mostly in the *Simiinæ,* in the most posterior part of the sacrum.

They always, except in the sacral and most or all caudal vertebræ, present the usual zygapophyses, and in some, especially in *Galago, Lagothrix,* and *Mycetes,* support the peculiar additional processes just mentioned (figs. 8, 11, & 2, *h*).

They are invariably more or less notched, for the exit of the spinal nerves, except in some *Nycticebinæ,* where (fig. 12) they are actually perforated by them. The increase in antero-posterior extent of the neurapophyses in the lumbar region varies, of course, with that of the whole vertebræ,—*Ateles* differing from the rest of the *Cebidæ* and from the long-tailed *Simiidæ,* and returning towards the Gibbon type, in the smallness of this increase.

In *Lemur,* and still more in *Indris,* the cervical neurapophyses dispute with the lumbar as to supremacy in antero-posterior development.

Sometimes two contiguous neural laminæ become anchylosed together, as in a skeleton of *Loris gracilis* (no. 67 *a*) in the British Museum.

Transverse Processes.

The true transverse process attains its maximum of development in the lumbar region.

After contributing to form the sacrum, these true transverse processes reappear as separate parts in the caudal vertebræ of all the long-tailed species, dividing in the more posterior caudal vertebræ in the way that has been described.

In *Lemur* alone, and not always in that genus, a second and more posterior transverse process appears in the hinder part of the lumbar region, as has already been noticed.

Sometimes the transverse process becomes much antero-posteriorly expanded at its distal end; and sometimes (as in *Cheiromys*) a backwardly directed process is developed from its posterior margin, similar in form and direction to the anapophysis, but external to the latter.

The mammillary and accessory supplemental processes (*i. e.* the metapophyses and anapophyses), which are more or less visible in the dorsal transverse processes, must be separately noticed.

Metapophyses.

These processes generally attain their maximum of development in the lumbar region, and are sometimes with difficulty distinguishable except in that portion of the vertebral column. This is particularly the case in Man and the *Simiinæ*, though there is considerable variation in this respect.

In Man these processes, in rare instances, begin to be well marked as high up as the tenth dorsal vertebra, sometimes at the eleventh, but generally, perhaps, at the twelfth. They are always tolerably distinct on the first and second lumbar vertebræ, but sometimes cease to be distinguishable at the third lumbar; in other instances, however, they may be distinctly traced throughout the lumbar region.

In *Troglodytes* and *Simia* they become distinct at about the twelfth dorsal, remaining visible in all the lumbar vertebræ of the Gorilla, but generally disappearing at the second or third lumbar in the Chimpanzee and Orang, especially in the latter.

In *Hylobates* these processes are sometimes already very marked in the eleventh dorsal vertebra, sometimes only slightly so even in the thirteenth; they are mostly, but not always, distinct in the lumbar region.

In the great bulk of the order—that is to say, in the *Semnopithecinæ* and in the *Cynopithecinæ* (except *Inuus*), in the *Cebidæ* (except *Ateles*), in the *Hapalidæ*, and all the *Lemuroidea* (except *Indris, Tarsius*, and the *Nycticebinæ*)—they are developed to a more or less similar extent, and always to a much greater one than in Man and the *Simiinæ*; for they begin to be conspicuous at the eighth or ninth dorsal vertebra, though sometimes much earlier; they mount as it were on the summit of the anterior zygapophysis at from the tenth to the twelfth, or very rarely thirteenth dorsal vertebra. They then continue very marked in the lumbar region, projecting strongly upwards and forwards from the summits of the anterior zygapophyses; they are distinguishable in the sacrum, and are visible, as a process more or less distinct from the anterior zygapophysis, in the first few caudal vertebræ; but further back they coalesce with, or replace, that process.

In *Ateles* the metapophyses are distinguishable throughout the dorsal series, but are very little marked in the lumbar region.

In *Indris* they do not become easily discernible till the last two dorsal vertebræ, but they are marked in the lumbar vertebræ.

In *Tarsius* these processes attain their maximum, not in the dorsal or lumbar, but in the anterior part of the caudal region.

In the *Nycticebinæ* the metapophyses are not conspicuously* developed in the trunk vertebræ, most so perhaps in *Perodicticus*.

As to the extent to which the metapophysis can be traced backwards along the spinal column, as might be anticipated, it is in *Ateles* that it can be furthest followed; its amalgamation with the anterior zygapophysis sometimes not taking place, in that genus, till the ninth caudal vertebra. In the other *Cebidæ* this union takes place generally at from the fifth to the seventh, though in *Mycetes* not till the eighth caudal vertebra. In *Lemur* it generally occurs at about the seventh caudal. In almost all the long-tailed *Simiidæ* the metapophyses are distinct in the first three, four, or five vertebræ, the amalgamation with the anterior zygapophysis taking place at the fourth, fifth, or sixth caudal vertebra. In *Inuus* and the very short-tailed *Cynocephali*, as in Man and the *Simiinæ*, metapophyses are not at all or scarcely to be traced backwards beyond the sacrum; in *Indris* they are scarcely distinct in the second caudal vertebra.

As to the extent to which the metapophysis can be traced forwards along the spinal column, there is considerable variation. As has been already recognized by others†, it can often be easily distinguished even in the first dorsal vertebra; but I am not aware that its existence in the cervical vertebræ of any Primate has yet been observed;

Fig. 6.

Axis and four following cervical vertebræ of *Ateles*, from the Museum of the Royal College of Surgeons (nos. 4694, 4695). Nat. size. *m*. Metapophysis.

nevertheless it is often more or less traceable in the cervical region, but most distinctly so in the genera *Ateles*, *Perodicticus*, and *Arctocebus*, and sometimes in *Simia*.

In *Ateles* this process is plainly distinguishable‡ as far as the third

* They are really well developed, but extend so little upwards as to be comparatively inconspicuous.

† Prof. Owen on the Megatherium, 'Phil. Trans.' part 2 for 1851, p. 727.

‡ Especially in the cervical vertebræ (nos. 4694–4696) preserved in the Museum of the Royal College of Surgeons, and in nos. 808 *d* & 808 *e* in the British Museum, where the first two dorsal vertebræ show the metapophyses advancing inwards and preparing, as it were, to underlap the anterior zygapophyses of the cervical vertebræ.

cervical vertebra, appearing as an obtuse prominence developed from beneath the anterior zygapophysis.

In both *Perodicticus* and *Arctocebus* it is also plainly to be recognized in the corresponding vertebræ, and is similar in form and position to the cervical metapophysis of *Ateles*.

That this prominence is really metapophysial in its nature is made evident by the fact that in the *Edentata*, where these as well as the other vertebral processes are carried to their maximum of development, the metapophyses are continued into the cervical region in the very same situation (viz. dipping beneath the anterior zygapophyses), as may be well seen in the two-toed Sloth (in spite of the poor development of the metapophyses in its trunk vertebræ*), also in *Orycteropus*†, and especially in the Pangolin‡. The existence of similar tubercles in the cervical vertebræ of *Myrmecophaga tamandua* and *Myrmecophaga jubata* has already been recorded by Professor Owen, who has fully recognized their metapophysial nature§. In this last-mentioned genus the metapophyses are very marked in the cervical region, and are developed with a singular uniformity from the anterior cervical to the posterior caudal vertebræ.

In the other genera of Primates‖ this process is not so distinctly to be traced in the cervical vertebræ; yet often the under surface of the anterior zygapophyses of the fourth, fifth, or sixth cervical vertebræ is strongly convex, as is, at least sometimes, the case in the genus *Homo*¶; and doubtless this prominence in all cases is, so to speak, a latent metapophysis.

In the Orang** I have noticed a condition which is common enough in many genera of Mammals, namely, such an extension of the cervical metapophysis, that part of it is continued on to the posterior part of the vertebra next in front, part of a cervical metapophysis occupying its normal position beneath the anterior zygapophysis of one vertebra, the other part being situated outside and partly upon the posterior zygapophysis of the vertebra anterior to it. I have not observed this in any other Primate besides the Orang, except Man, in whom, at least sometimes††, a more or less similar condition obtains.

* Noticed by Prof. Owen, 'Memoir on the Megatherium,' p. 740.

† See detached cervical vertebræ (no. 2339) in the Museum of the Royal College of Surgeons.

‡ No. 2363 A in the Museum of the Royal College of Surgeons.

§ Memoir on the Megatherium, pp. 745, 746.

‖ In the British Museum there is a skeleton of an Orang (nos. 43, 10, 2, 1) in which the seventh cervical vertebra shows distinctly the metapophysis close to and just outside of the anterior zygapophysis, ready to dip beneath it in the sixth. Also, in a skeleton of *Cercopithecus albogularis* (no. 17 *b*), the metapophyses are distinctly visible throughout the dorsal vertebræ, those of the first two dorsal being more internally situated than are those behind, so that the margin of the anterior zygapophysis of the first dorsal vertebra seems quite in series with them. The same approach of the metapophyses to the anterior zygapophyses takes place in a very marked way in the first dorsal vertebra of a skeleton of *Mycetes* (no. 44 *a*), and in that of *Ateles subpentadactylus* (no. 38 *b*).

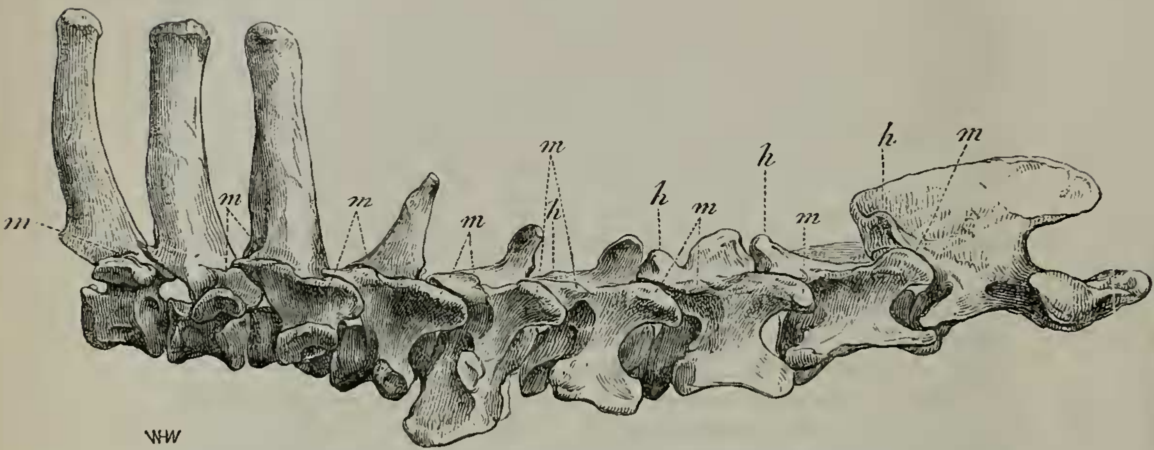
¶ Well seen in the fourth, fifth, and sixth cervical vertebræ of a human spine in the Museum of St. Mary's Hospital.

** See skeleton (nos. 45, 10, 2, 2, 3 *c*) in the British Museum.

†† *E.g.* a set of human cervical vertebræ in my own collection.

This peculiar condition of the cervical metapophysis is well seen in large specimens of the genus *Canis**, in which (figs. 7 & 9, *m*) the third dorsal vertebra, like all those posterior to it, bears its own metapophysis only, and supports the whole of it. The second dorsal

Fig. 7.



First three dorsal vertebræ and all the cervical vertebræ, except the atlas, of *Canis dingo*. One-half nat. size. *m*. Metapophysis. *h*. Hyperapophysis.

vertebra bears but a portion of its metapophysis, which is continued on to the first dorsal vertebra. This first dorsal supports the other part of the metapophysis of the second dorsal, but scarcely any of its own, which, on the other hand, is almost entirely borne by the seventh cervical vertebra upon its posterior zygapophysis. The sixth cervical vertebra similarly supports the metapophysis of the seventh cervical; but in addition it bears, beneath and outside its anterior zygapophysis, a marked portion of its own true and proper metapophysis. The same is the case in the fifth cervical vertebra; the fourth, however, bears scarcely any of the metapophysis of the fifth cervical, but, on the other hand, has its own metapophysis well developed, and situated in its normal position, beneath the anterior zygapophysis.

In the Malay Tapir† the cervical metapophyses are strongly marked, and are somewhat divided, the greater part of each being in the normal position beneath the anterior zygapophysis, but part also being above the posterior zygapophysis next in front, in the last five cervical vertebræ.

In the Indian Rhinoceros‡ the cervical metapophyses are almost entirely confined to the anterior zygapophyses.

* See mounted skeleton of *C. occidentalis* in the British Museum. Also no. 4364 (Arctic Wolf) in the Osteological Collection of the Museum of the Royal College of Surgeons.

† No. 2866 of the Osteological Collection in the Museum of the Royal College of Surgeons.

‡ No. $\frac{A}{2969}$ in the same collection.

In the Sumatran Rhinoceros*, however, they are pretty equally divided.

A similar prolongation forwards of the cervical metapophyses takes place in the Ox†.

In *Ursus*‡ I have found the cervical metapophyses very strongly marked, and entirely confined to their normal position beneath the anterior zygapophyses.

In the *Megatherium*§ they are situated rather behind the anterior zygapophyses of the cervical vertebræ.

Anapophyses.

These processes are also, in the main, lumbar processes. In Man they are generally confined to the first two lumbar and last dorsal vertebræ, though they are sometimes distinct at the eleventh dorsal and rarely even on the fifth lumbar. In all cases, however, they are very feebly developed, as is the case also in the *Simiinæ*.

In *Troglodytes* and *Simia* they are distinct from the eleventh dorsal to the second lumbar, but less marked in the lumbar than even in the dorsal region, especially in *Simia*.

In *Hylobates* there is much variation; but generally they are pretty distinct from about the tenth to the fifteenth trunk-vertebra, sometimes, however, as early as the third dorsal.

In all the rest of the order (except some of the *Nycticebinæ*) they are much more developed, forming long processes in the lumbar region, each process projecting backwards outside and beneath the anterior zygapophysis of the vertebra next behind.

In the *Semnopithecinæ* and *Cynopithecinæ* they are generally distinct processes as early as the eighth dorsal vertebra, and continue such to the penultimate lumbar; in the *Cebidæ* they are generally distinct at about the ninth or tenth, but in *Nyctipithecus* not quite so till the fourteenth dorsal vertebra.

In *Ateles* they are shorter than in *Lagothrix* and the other *Cebidæ*, and disappear at the fourth lumbar.

In *Lemur* they become marked at about the eleventh dorsal vertebra; in *Indris* at the twelfth.

In the *Nycticebinæ* they are not distinct till we come quite to the end of the dorsal region, and, except in *Perodicticus*, they are little marked even in the lumbar vertebræ.

In *Tarsius* they are inconspicuous throughout the whole of the trunk-vertebræ.

The anapophyses appear to attain their maximum of relative size in the lower *Cebidæ*.

Generally, in the last lumbar vertebra, the process in question appears to coalesce with the base of the true transverse process; and if we may consider the terminal lateral processes of the sacrum the

* No. 2933 in the same collection.

† No. 3825 in the same collection.

‡ A skeleton in my own collection.

§ See Professor Owen's memoir on the Megatherium, 'Phil. Trans.' 1855, vol. cxlv. p. 375, and pl. 20. fig. 5.

single backwardly projecting transverse processes of the first few caudal vertebræ, and the hinder part of each divided transverse process of the more posterior caudal vertebræ as serially homologous with the lumbar anapophyses, then this process continues to be developed almost to the posterior extremity of the spinal column.

The extent to which the anapophysis may be traced forwards varies much. In some Gibbons it can be plainly distinguished on the transverse process of the third dorsal vertebra. It can often, in the *Simiadæ*, be traced to the first dorsal; but in *Cynocephalus** it sometimes appears as a minute projection on the dorsum of the outer end of each of the upper or diapophysial transverse processes of the four posterior cervical vertebræ.

I am not aware that the serial homologues of the lumbar anapophyses have before been noticed in the cervical region; but I have no doubt that they do exist in many forms, and that they may even be represented in Man himself by the backwardly projecting extremities of the upper part of each bifurcated transverse process.

In *Ateles*† these processes are distinctly traceable in the cervical region (fig. 6) as tubercles backwardly projecting from the distal ends of the upper (diapophysial) transverse processes of the fifth, sixth, and seventh cervical vertebræ.

In many individuals of different species‡, in which the dorsal anapophyses are well marked; by following these latter forwards it becomes pretty evident that the more or less backwardly projecting extremity of the upper portion of the cervical transverse process is in series with these dorsal anapophyses, and therefore that these processes do in fact sometimes extend almost from one end of the vertebral column nearly to the other—that is, of course, if the interpretation previously suggested for the caudal transverse processes be correct.

Hyperapophyses.

A more or less trifid neural spine, as has been said, exists in the axis vertebra of *Troglodytes* and some others. In *Mycetes* (fig. 1) the same vertebra has a distinctly trifid spine; and this character is repeated in the two or three following vertebræ.

In *Mycetes* also, as has likewise been mentioned, lateral backwardly projecting processes spring from the neural arch in the lumbar ver-

* *E. g.* in no. 4719 in the Museum of the Royal College of Surgeons.

† No. 4695 in the Museum of the Royal College of Surgeons.

‡ This, I think, is plainly to be observed in the following skeletons preserved in the British Museum:—In an Orang (nos. 3 B, 45, 10, 2, 8), where the backwardly projecting point of the seventh cervical vertebra appears to continue forwards the dorsal anapophyses. The same may be said of two specimens of *Colobus* (no. 1371 *b* and no. 1180 *a*). In *Cercopithecus albogularis* (no. 17 *b*), where the anapophyses of the ninth, tenth, and eleventh dorsal vertebræ bifurcate, these processes are plainly visible throughout the dorsal series; and the points of the cervical transverse processes are, I think, evidently their serial homologues. Perhaps this is even more marked in another individual of the same species (no. 17 *h*). The same thing is plainly visible in a young *Cynocephalus babouin* (no. 36 *c*), in *Macacus rhesus* (no. 30 *g*) to the fifth and sixth cervical vertebræ; and in *Inuus* (no. 32 *d*) it is distinctly traceable to the seventh.

tebræ, one on each side of the neural spine (fig. 2, *h*). Such processes are also found in other forms, e. g. *Lagothrix** (fig. 11, *h*), *Chrysothrix*†, *Nyctipithecus*‡, and *Hapale*§; but they attain their maximum in *Galago*‖ (fig. 8, *h*), where they exist both in the posterior dorsal and in the lumbar vertebræ, and are very marked, each pair of such backwardly projecting processes embracing between them the spinous process of the vertebra next behind. These extra processes¶ are somewhat similar to anapophyses, but are placed much higher, being above and within the posterior zygapophyses.

Now these lumbar extra processes, as they exist in *Mycetes*, seem certainly to be the serial homologues of the lateral parts of the cervical trifid spines. In *Galago* there is no cervical spinous process whatever, except that of the axis vertebra, which is more or less bifid; yet the cervical neural laminæ in that genus develope two faintly marked processes on the dorsum of each vertebra, which processes appear to continue backwards (*i. e.* to be serially homologous with) the lateral parts of the spine of the axis, in the same way that the extra processes of the cervical vertebræ of *Mycetes*** are evidently serially homologous with the lateral parts of the spine of the axis in that genus. Now, without doubt, the before-mentioned lumbar processes of *Mycetes* are the serial homologues of the cervical extra processes and of the lateral parts of the axis-spine; and therefore the same lumbar processes in *Galago* are also the serial homologues of the faintly marked processes of the cervical neural laminæ and of the lateral parts of the axis-spine in that genus.

Thus we have processes backwardly directed, and springing from the neurapophyses, which processes attain their maximum in the lumbar and third and fourth cervical vertebræ, and appear to be serially homologous with the lateral portions of a so-called bifid or trifid spine, whether of the axis or of some other vertebra.

Professor Owen remarks††, in speaking of the axis of an Australian Woman, "The neural spine is much less developed; in fact, what is usually described as the bifurcated spine of the axis seems rather

* See the skeleton of *Lagothrix* (no. A 4718 *a*) in the Museum of the Royal College of Surgeons, and that in the British Museum (numbered 43 *d*, 50, 11, 22, 61).

† See no. 932 *b* in the Osteological Collection of the British Museum. These processes are present in the last dorsal and first four lumbar vertebræ.

‡ See the skeleton of *N. villosus* in the British Museum.

§ They are very distinct in the last dorsal and first five lumbar vertebræ of *H. midas* (no. 1889 *a*). They are also marked in *H. œdipus* (no. 53 *a*) and *H. auritus*, all in the Osteological Collection of the British Museum.

‖ See the skeleton of *G. allenii* in the British Museum (no. 68 *d*).

¶ The processes in question are spoken of as "*griffelförmige Fortsätze*" by Creplin, the German translator of Retzius, in describing the spinal column of *Callithrix* (*Chrysothrix*?). See Müller's 'Archiv' for 1849, Heft vi. p. 614.

** In a *Macacus rhesus* (no. 30 *g*) in the same collection, the spines of the four last cervical and first dorsal vertebræ show traces of these processes, although the spine of the axis is in the same individual quite simple. In a skeleton of a Potto (no. 743 *a*) in the British Museum, there are also faint indications of these processes in the fourth, fifth, sixth, and seventh cervical vertebræ.

†† Osteological Catalogue, vol. ii. p. 807, preparation no. 5187.

to be the upper slightly produced extremities of the not completely coalesced neurapophyses of that vertebra in Man."

I do not for a moment pretend to assert that there is any fundamental distinction between a single, a bifid, and a trifid neural spine; at the same time it may be well to note these varieties of structure, and the fact that, as has been said, it is with the lateral parts of such trifid spines, or with the halves of such bifid spines, that these extra processes appear to be serially homologous.

In the genus *Canis* the axis and three following cervical vertebræ support processes, decreasing in size as we proceed from before backwards, which project posteriorly, and are situated upon, and rather internally to, the posterior zygapophyses. They are quite distinct from the cervical metapophyses, and disappear at the sixth cervical vertebra (figs. 7 & 9, *h*). Similar processes exist in other Carnivora, as the genus *Felis*, and in *Ursus labiatus**. On the other hand, they are quite wanting in the large marsupial Carnivore *Thylacinus*†.

Are these processes the homologues of those just described as existing in *Mycetes* and others?

I am disposed, provisionally at least, so to regard them; but, whether they are so or not, the extra processes existing in Primates are so marked in some species, and serve so well to distinguish certain groups one from another, that I cannot but think that it would be convenient and every way proper to bestow on them a distinct appellation; and recognizing fully as I do the great convenience, as Professor Owen has pointed out, of terms capable of being inflected adjectively, and desiring that the new term should harmonize with those already so happily devised, I propose for the process in question the term *hyperapophysis*.

Centrum.

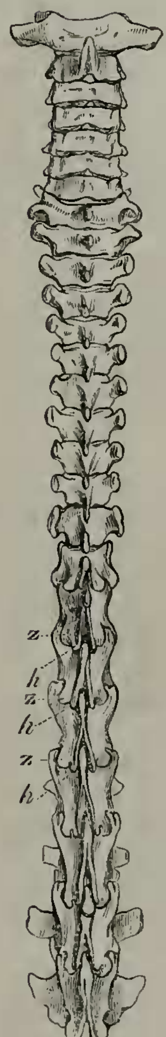
Speaking broadly, the bodies of the vertebræ of the different regions of the spine have much the same relative proportions throughout the *Anthropoidea*. They are relatively widest transversely in the cervical vertebræ, narrowest and shortest in the dorsal region, and expanded both in length and breadth in the lumbar.

In the *Lemuroidea*, except the *Nycticebinæ*, the elongated cervical centra alter the proportion. The *Nycticebinæ* differ from all the other forms in the small increase in breadth of their lumbar vertebræ, in which respect they are most nearly approached by the Gorilla.

I have not been able to detect in the vertebral column any distinctive characters separating the whole of one of the two primary divisions, or suborders, of the Primates from the whole of the other, parallel to the cranial and dental distinctions which so well characterize those two groups respectively. It is the great variety of structure presented by the second suborder (*Lemuroidea*) which renders it difficult or impossible to give satisfactory spinal distinctive characters; for the typical Lemurs present marked differences enough

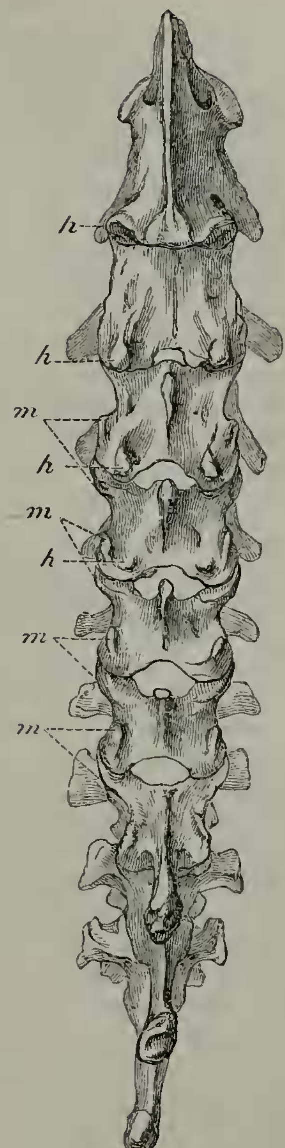
* *E. g.* skeleton (no. 4037) in the collection of the Royal College of Surgeons.
† *E. g.* skeleton (no. 1984) in the same collection.

Fig. 8.



Spine of *Galago allenii*, from the British Museum. Nat. size.
z. Posterior zygapophysis.
h. Hyperapophysis.

Fig. 9.



First three dorsal vertebræ and all the cervical vertebræ, except the atlas, of *Canis dingo*. One-half nat. size.
m. Metapophysis.
h. Hyperapophysis.

from the whole of the *Anthropoidea*, which last have much uniformity of structure, and may be characterized as follows:—

Anthropoidea.

Cervical vertebræ always short; atlas with the extremities of its transverse processes always bent upwards, and its two posterior articular surfaces always separated by an interval; transverse processes of the fifth cervical vertebra always bifurcating; ribs sometimes as few as eleven pairs, but never more than fourteen; lumbar vertebræ scarcely ever more than seven*; increase in breadth of the bodies of the posterior as compared to the anterior dorsal vertebræ generally considerable; third, fourth, fifth, and sixth cervical vertebræ always with distinct neural spines; sternum sometimes formed of as few as two bones in the adult; neurapophyses never perforated by the spinal nerves.

The first family, *Hominidæ*, possesses many characters in common with the *Simiinæ*; in fact, were we to consider the spinal structure only, the *Simiinæ* would be united to the *Hominidæ*, or would rank as a family by themselves, so widely do they differ from the rest of the *Simiidæ*.

Hominidæ and Simiinæ.

A more or less perceptible sigmoid curve in the spinal column; the vertebral artery sometimes grooves, sometimes perforates the neural arch of the atlas; dorsal vertebræ normally twelve; thirteen, or fourteen; no dorsal or lumbar neural spines forwardly directed; lumbar transverse processes short and never bent ventrally; metapophyses and anapophyses but very little developed†; sacrum large and solid, always consisting of four vertebræ at the least, and tapering gradually backwards; caudal vertebræ never more than seven, and destitute of complete neural arches, metapophyses, anapophyses, and hypapophyses, and always decreasing in length from before backwards; sternum broad and short, often with only one bone between the manubrium and the xiphoid cartilage; spine of axis generally more or less distinctly bifid or trifid; increase in antero-posterior diameter of spinous processes (as we survey the spine from before backwards) at its minimum; last sacral vertebra with its neural arch generally imperfect.

Hominidæ.

Spinal column with a strongly marked sigmoid curve; dorsal and lumbar vertebræ together seventeen in number; transverse processes of dorsal and lumbar vertebræ inclined upwards (backwards); lumbar transverse processes arising at a high level, through elongation of the crura of the neural arches‡; metapophyses not distinct before the

* De Blainville mentions a Baboon with eight lumbar vertebræ.

† Prof. Owen, in his interesting 'Memoir on the Gorilla,' recently published, gives as the most conspicuous osteological characters of his group *Pithecina* (my *Simiinæ*) "the great relative breadth and flatness of the sternum, the reduction of the caudal vertebræ to a non-projecting 'os coccygis,' and the feeble met- and anapophyses in the lumbar vertebræ." See 'Memoir on the Gorilla,' 1865, p. 46.

‡ Noticed by Prof. Owen, 'Trans. Zool. Soc.' vol. iv. p. 105.

tenth, and anapophyses not before the eleventh, dorsal vertebra; sacrum always consisting of five vertebræ, without counting the last lumbar, which rarely anchyloses with it; three sacral vertebræ generally articulate with the ilium; sacrum concave anteriorly, both antero-posteriorly and transversely; sacro-vertebral angle very marked; no anapophysial process at posterior end of sacrum; ribs twelve pairs, with strongly marked angles, and with their proximal portions arching much backwards, more so than in any other Primate, also with the vertical sigmoid twist at its maximum; breadth of thorax to its depth as about three to two; transverse process of third cervical vertebra always bifurcated; spinous processes of second, third, fourth, and fifth cervical vertebræ generally bifurcated, never very elongated; of the cervical spines, that of the seventh cervical vertebra the longest.

Simiinæ.

Spinal column with a scarcely perceptible sigmoid curve; sacrum very elongated relatively, and generally flattened anteriorly. If three sacral vertebræ join the ilium, then one answers to the last lumbar of Man. Sacro-vertebral angle very slightly marked; an anapophysial process on each side at posterior end of sacrum; ribs twelve or thirteen (rarely fourteen) pairs, and forming a thorax the transverse diameter of which is still very considerable; spinous processes of third, fourth, fifth, and sixth cervical vertebræ never bifid; transverse process of third cervical vertebra very rarely bifurcating.

The first two genera of this family have much in common, thus:—

Troglodytes and Simia.

Dorsal and lumbar vertebræ, taken together, seventeen in number; ribs twelve or thirteen pairs; transverse processes of lumbar vertebræ inclined somewhat upwards; spines of most cervical vertebræ very elongated, but not bifurcated; axis-spine more or less bifid or trifid; anapophyses very slightly developed; bodies of dorsal vertebræ increasing but slightly in breadth posteriorly; last lumbar vertebra very often anchylosed to sacrum; lumbar vertebræ never more than five in number.

Troglodytes.

Ribs normally thirteen pairs; neural foramina of sacrum much smaller than in Man; sacro-vertebral angle exceedingly slight; sacrum very flat anteriorly.

Sternum of *T. gorilla* much wider (below the manubrium) than that of *T. niger*.

Simia.

Ribs only twelve pairs; neural foramina of sacrum as large or larger than in Man; sacro-vertebral angle more marked than in *Troglodytes*; antero-posterior concavity of anterior surface of sacrum generally very marked; anterior margin of manubrium much thickened; sternum peculiarly composite; anapophyses often scarcely perceptible in lumbar region; transverse process of sixth cervical vertebra sometimes imperforate.

Hylobates.

Dorsal and free lumbar vertebræ, taken together, generally eighteen in number; ribs twelve to fourteen pairs; last lumbar vertebra always anchylosed to sacrum ; sometimes as many as six lumbar vertebræ ; spines of cervical vertebræ neither elongated nor bifurcating ; anapophyses generally more developed than in the higher forms.

This genus presents us, in the Siamang (*H. syndactylus*), with the broadest and relatively shortest sternum to be found in the whole order.

Nearly all the rest of the Primates—that is to say, all the Simiidæ (except the *Simiinæ*), all the Cebidæ, Hapalidæ, and Lemuroidea, with a few exceptions, present the following common characters :—

Dorsal and lumbar vertebræ, taken together, almost always exceed eighteen in number ; the vertebral artery perforates the neural arch of the atlas * ; metapophyses and anapophyses generally very conspicuous ; caudal vertebræ generally numerous, and always one at least has a complete neural arch ; spines of last dorsal and of lumbar vertebræ forwardly directed (except the *Nycticebinæ* and *Ateles*) ; lumbar transverse processes often inclined downwards ; sacrum not tapering gradually (except *Indris* and the *Nycticebinæ*), and very rarely consisting of as many as four vertebræ. Except in a very few, the caudal vertebræ increase in length after the first two or three. Caudal vertebræ with well-marked transverse processes, generally divided ; hypapophyses present in caudal region, except in *Inuus*, *Indris*, and the *Nycticebinæ* ; sternum elongated, and always with three or more bones, in the adult, between the manubrium and xiphoid cartilage ; thorax deeper and less broad relatively than in the two first families ; fourth, fifth, and sixth cervical spines never bifurcating, and (except in *Perodicticus* and *Arctocebus*) never very elongated.

Characters presented by all the Simiidæ, *except the* Simiinæ.

Dorsal vertebræ from 11 to 13 ; lumbar vertebræ 6 or 7 ; together generally 19, rarely 18 or 20 in number ; generally 2, rarely 3, very rarely 4 sacral vertebræ ; neural spines begin to incline forwards at the eleventh or twelfth dorsal vertebra † ; the metapophysis interrupts the dorsal vertebral groove by mounting on the anterior zygapophysis at the tenth or eleventh dorsal vertebra ; anapophysis distinct, at the latest, at the ninth, and long at the eleventh dorsal vertebra ; only one or two true sacral vertebræ articulate with the ilium ; caudal vertebræ begin to increase in length at the second or the third caudal vertebra ‡. Neural spine of third cervical vertebra short and simple § ;

* Not so in *Semnopithecus nasalis* (no. 6 *c*) in the British Museum.

† At the thirteenth in *C. porcarius* (no. 35 *d*) in the British Museum.

‡ This, of course, is not the case in *Inuus* ; and there are exceptions, as the *Macacus nemestrinus* and *M. speciosus* in the British Museum, already mentioned.

§ This process very rarely exhibits an incipient bifurcation, as in *Colobus vellerosus* (no. 1391) in the British Museum, and in *Cynocephalus sphinx* (no. 34 *c*) in the same collection.

that of seventh cervical the longest, or equal to the longest of the cervical spines; transverse process of third cervical vertebra very rarely bifurcating, those of fourth and fifth cervical vertebræ always so; relative extent of lumbar region great, that of sacral region very small.

Semnopithecinæ.

In the two genera composing this subfamily we find the greatest absolute length of tail existing in the order, also the absolutely longest individual caudal vertebræ; there is also generally one bone less to the sternum than in the *Cynopithecinæ* *, there being mostly but four bones interposed between the manubrium and the xiphoid cartilage.

Cynopithecinæ.

Macacus.

In this genus the hypapophyses and chevron bones are more developed than in any other of the *Simiidæ*.

Inuus.

This form (which, when considering the structure of the spine alone, it is convenient to rank as a separate genus) is very distinct from the *Semnopithecinæ* and from all the other *Cynopithecinæ* as regards the structure of the posterior end of the vertebral column, though

Fig. 10.

Caudal vertebræ of *Inuus* (no. 32 *b*) in the British Museum. Nat. size.

from the atlas to the posterior end of the sacrum it is quite like the other Macaques. Thus the most marked characters are—caudal vertebræ from two† to four in number; caudal transverse processes

* This has been noticed by De Blainville, 'Ostéog. Primates,' p. 22.

† Vrolik says two (see *l. c.* p. 10). In the skeleton (no. 32 *d*) in the British Museum there are only two caudal vertebræ, but the second is evidently composed of two anchylosed together; it has a very narrow, yet complete, neural arch. In the specimen no. 32 *f*, also in the British Museum, there are four caudal vertebræ, the two first having complete neural arches. In no. 32 *b* there are also four caudals (the two last being anchylosed together), and three have each a complete neural arch.

undivided; no hypapophyses; caudal vertebræ flat and broad, each successive vertebra being less than its predecessor in all dimensions, like those of the coccyx of the *Simiinæ*. In the allied Japanese form, *Macacus speciosus**, there are ten caudal vertebræ; the third caudal is scarcely, if at all, longer than the second; but the fourth is longer than the third caudal vertebra; there are slight hypapophyses and chevron bones.

Cynocephalus.

Transverse process of axis and that of third cervical vertebra sometimes bifurcating; dorsal and lumbar vertebræ, taken together, sometimes only eighteen in number; sometimes as many as four sacral vertebræ; sacro-vertebral angle often strongly marked, as also the antero-posterior concavity of sacrum; relative breadth of sacrum at its maximum; hypapophyses present; anterior margin of manubrium much thickened; atlas vertebra occasionally developing a short neural spine. In some at least there appears† to be a decided return towards the sigmoid curve of the spinal column existing in Man.

The American *Anthropoidea* have but very few characters in common tending to distinguish them from the Old-World forms.

Cebidæ.

Three first caudal vertebræ quite short, the increase in length not taking place till the fourth; dorsal vertebræ from twelve‡ to fifteen in number; twelfth dorsal spine turned forwards (except in *Ateles*); spines of the third and fourth cervical vertebræ often curving over in a forward direction; spine and transverse process of third cervical not bifurcating; spine of the seventh cervical§ the longest, or equal to the longest of the cervical spines; lumbar spinous processes (except in *Ateles*) very long, and curving over in a forward direction in a very marked manner; generally two, rarely three, very rarely four, sacral vertebræ; only one or two sacral vertebræ articulate with the ilium (except sometimes in *Ateles*); sacro-vertebral angle almost always obsolete; transverse processes of lumbar vertebræ (except in *Ateles*) inclined strongly downwards and forwards.

Ateles.

This genus presents many exceptional characters in its vertebral structure.

Neural laminæ rather long; marked cervical metapophyses (fig. 6, *m*); dorsal region at its maximum of relative length in the

* No. 1083 *a* in the British Museum.

† *I. e.* as far as can be judged from skeletons only.

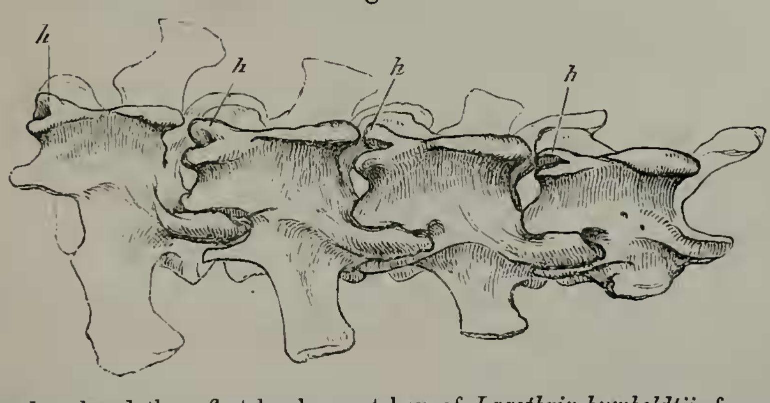
‡ In *Callithrix personatus* (no. 51 *d*), in the British Museum, there are but eleven dorsal vertebræ.

§ Wagner says that the transverse process of the seventh cervical vertebra is never perforated in any of the American Primates, Man of course excepted. See 'Beitr. zur Kennt. der Wirbelthiere Amerika's, osteolog. Beitr. zur Kenntniss der amerikanischen Affen,' p. 457.

family; all the dorsal spines backwardly inclined or vertical*; mostly four, sometimes five, lumbar vertebræ; dorsal and lumbar vertebræ, taken together, only eighteen, or even only seventeen, in number†; lumbar neural spines scarcely inclined forwards; transverse processes of lumbar vertebræ not bent downwards, and arising from a higher level than in other *Cebidæ*; transverse diameter of thorax exceeds its depth; sacrum generally composed of four vertebræ, three often articulating with the ilium; sacral region longer in proportion to the rest of the spine than in any other of the *Cebidæ*, or any of the *Simiidæ* below *Hylobates*; number of caudal vertebræ at its maximum in the order; proportion of caudal region to other vertebral regions at its maximum; longest individual caudal vertebræ situated further from the root of the tail than in other long-tailed forms; eight caudals with a complete neural arch to each; five or six caudals with a neural spine each; caudal zygapophyses articulate with each other till the eighth caudal vertebra; caudal metapophyses distinct to the same vertebra; anterior and posterior divisions of the caudal transverse processes not attaining equality till the ninth caudal vertebra; transverse processes of the first six caudal vertebræ very long and strong; hypapophyses and chevron bones at their maximum, and in the posterior caudal vertebræ they are the largest of the caudal processes; terminal caudal vertebræ thick.

This genus also differs from all the rest of the *Cebidæ* and from all *Semnopithecinæ* and *Cynopithecinæ* in the small increase in antero-posterior extent of the lumbar neurapophyses and spines as compared to those of the dorsal region, and in the shortness of the lumbar anapophyses.

Fig. 11.



Last dorsal and three first lumbar vertebræ of *Lagothrix humboldtii*, from the Museum of the Royal College of Surgeons. Nat. size. *h*. Hyperapophysis.

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* De Blainville remarks this (*l. c.* p. 10); but in the skeleton (no. 38 *b*) in the British Museum the thirteenth and fourteenth dorsal spines are turned slightly forwards.

† As in two skeletons in the Museum of the Royal College of Surgeons (nos. 4690 & 4697).

Lagothrix*.

In this genus there are fourteen dorsal, four lumbar, and three sacral vertebræ. The hypapophysis of the atlas is very largely developed, as are the hypapophyses and chevron bones of the caudal region. The axis-spine has a trifid tendency. The cervical spines are not curved over in a forward direction, nor are there any cervical metapophyses; but hyperapophyses are largely developed in at least the last three dorsal and first four lumbar vertebræ, and the lumbar anapophyses are very long and strong. There are five caudal vertebræ with spinous processes, and seven with a complete neural arch.

Cebus.

Wagner says† of this genus, that the terminal caudal vertebræ are intermediate in form between those of *Ateles* and *Mycetes* and the slender terminal ones of the lax-tailed *Cebidæ* and of *Hapale*.

Mycetes.

Manubrium (figs. 4 & 5, *m*) remarkably divided in the middle line‡. Axis with a trifid spine; hyperapophyses in the neck and trunk (figs. 1 & 2, *h*); no cervical metapophyses; anterior cervical spines rather elongated; hypapophysis of atlas produced very strongly backwards beneath the axis; terminal caudal vertebræ thick; sometimes only four bones between manubrium and xiphoid cartilage§.

In all the rest of the *Cebidæ* and in *Hapale* the posterior caudal vertebræ are long and slender‖.

Pithecia¶.

In this genus the ribs attain the greatest relative breadth of the whole order; and the costal element of the sixth cervical vertebra is scarcely larger than that of the fifth.

Brachyurus.

Here there are sometimes four sacral vertebræ**, the sacrum being strongly concave antero-posteriorly, long, narrow, and tapering.

Callithrix.

Sometimes in this genus there are but eleven dorsal vertebræ††, the

* I have only seen two skeletons of this genus—one in the British Museum (nos. 43 *d*, 50, 11, 22, 61), the other in the Museum of the Royal College of Surgeons (no. A 4718 *a*).

† *L. c.* p. 461.

‡ As has been before observed, it is completely cleft in the specimen preserved in the Museum of the Royal College of Surgeons, as well as in the one in the British Museum; and De Blainville speaks of it as "*profondément bifurqué*" (Ostéog. Primates, *Cebus*, p. 16).

§ *E. g.* in no. 44 *a* in the Osteological Collection of the British Museum.

‖ Wagner, *l. c.*, and in Suppl. to Schreber's Säug. Abtheilung, v. p. 97.

¶ See the skeleton of *P. monachus* in the Museum of the Royal College of Surgeons.

** See *B. calvus* (no. 806 *b*) in the British Museum; it has seventeen caudal vertebræ.

†† As in *C. personatus* (no. 51 *d*) in the British Museum.

spine of the ninth dorsal being turned forwards, and there being but four bones between the manubrium and the xiphoid cartilage.

Chrysothrix.

Transverse processes of the caudal vertebræ undivided, forming a long ridge on each side*. Manubrium with a process on each side for the first rib; hyperapophyses in last dorsal and first four lumbar vertebræ†.

Nyctipithecus.

Here the dorsal vertebræ are from thirteen to fifteen, the dorsal and lumbar vertebræ together being generally as many as twenty-two‡ in number; yet the dorsal region is relatively shorter, as compared with the other precaudal regions, than in Man, *Pithecus*, or *Troglodytes*; on the other hand, the lumbar region is relatively the longest in the whole order, the individual lumbar vertebræ being relatively so much elongated. The spines of the lumbar vertebræ are very much prolonged forwards.

Hapalidæ.

Spine of axis sometimes bifid, that of third cervical vertebra always short and simple; transverse process of third cervical vertebra generally bifurcating; spines of cervical vertebræ never arching over forwards; dorsal vertebræ twelve or thirteen in number; tenth dorsal spine often turned forwards; sometimes the third caudal vertebra is more elongated than the two preceding§, as in the *Simiidæ*. Hyperapophyses sometimes present in last dorsal and anterior lumbar vertebræ‖; transverse processes of lumbar region long, and strongly inclined downwards and forwards; sacro-vertebral angle obsolete; spines of lumbar vertebræ arching over forwards very strongly.

Lemuroidea.

This suborder, as has already been said, presents a great variety of structure; and I have not detected¶ any universal characters separating it from the *Anthropoidea*, though conditions often exist in it which are not found in the last. The transverse processes of the atlas have almost always their extremities inclined ventrally; and very often

* Noticed by Wagner, 'Amerik. Affen,' p. 460.

† See skeleton (no. 932 *b*) in the British Museum.

‡ De Blainville says, 14 d. + 8 l. = 22 (*l. c.* p. 20). Wagner, in 'Beiträge zur K. der amerik. Affen,' p. 426, gives the same number in his careful description of the osteology of this genus. In the specimen preserved in the Museum of the Royal College of Surgeons there are 15 d. + 7 l. = 22. In *N. villosus* (no. 58 *b*) in the British Museum there are only 13 d. + 8 l. = 21; and in *N. felinus* there are 14 d. + 8 l. = 22.

§ E. g. *Hapale aurita* (nos. 62, 3, 19, 17) in the British Museum.

‖ As in *H. midas* (no. 1889 *a*) in the British Museum, and *H. œdipus* (no. 53 *a*).

¶ Unfortunately I have not been able to meet with a skeleton of any of the following genera:—*Propithecus*, *Microrhynchus*, *Hapalemur*, *Microcebus*, *Lepilemur*, and *Cheirogaleus*.

the atlas has but one posterior articular surface, the two posterior zygapophyses uniting in the middle line. The transverse process of the fifth cervical vertebra is sometimes simple, and does not bifurcate. The transverse processes of all the cervical vertebræ project more sharply backwards than in the *Anthropoidea*. The ribs are never so few as eleven pairs, while they are occasionally as many as sixteen pairs. There are sometimes as many as nine lumbar vertebræ. The increase in breadth and length of the posterior as compared with the anterior dorsal vertebræ is very slight. Sometimes the third, fourth, fifth, and sixth cervical vertebræ are quite destitute of neural spines. The cervical vertebræ are often very much extended antero-posteriorly. The sternum is never formed of so few as two or three bones in the adult; and the first three caudal vertebræ are short. Except in the *Nycticebinæ*, the atlas is furnished with wide and long transverse processes; there are, with the same exception, never more than thirteen pairs of ribs, but (except in *Indris*) always hypapophyses and more or less complete chevron bones, and, as in the *Anthropoidea*, the neurapophyses are not perforated by the spinal nerves.

Indris.

This very remarkable form presents us with spinal characters at least as marked and distinct from those of the other *Lemuroidea* as are the spinal characters of Man from those of the rest of the *Anthropoidea*. Atlas with one posterior articular surface only; spine of axis extending forwards at the summit, but not backwards; spines of third, fourth, and fifth cervical vertebræ rather elongated; neural lamina of third cervical vertebra split behind, so that its spinous process springs from quite its anterior end; anterior zygapophyses advancing much in front of the roots of the neurapophyses; transverse processes of neither the third, fourth, nor fifth cervical vertebra bifurcated; neural lamina of seventh cervical vertebra shorter than that of any of the other cervical vertebræ; cervical region exceeding one-fifth the length of the spine (exclusive of the tail), and nearly five times as long as broad; lumbar vertebræ eight* or nine† in number; spinous processes of lumbar vertebræ vertical; neural laminæ of the dorsal vertebræ shorter, and those of the lumbar vertebræ scarcely, if at all, longer than those of the cervical vertebræ; sacrum often composed of as many as four vertebræ, and tapering posteriorly; spinous processes of sacrum long and flattened at their summits; transverse diameter of thorax considerably exceeding its depth; dorsal region less relatively extended than in all the rest of the order; cartilages of ribs slightly dilate before joining the sternum‡; caudal vertebræ few and more or less decreasing in length posteriorly§; no trace of hyperapophyses; no caudal chevron bones,

* As in skeleton in the British Museum.

† As in skeleton in the Museum of the Royal College of Surgeons.

‡ Noticed by De Blainville, 'Ostéographie,' *Lemur*, p. 21.

§ In the skeleton in the British Museum there are fourteen caudal vertebræ: the first two are about equal in length; they then decrease in all dimensions to the sixth inclusive.

but the lowest part of each cervical centrum is remarkably prolonged in a backward direction as a hypapophysial ridge *.

Lemur.

This genus agrees with the last in the very elongated cervical vertebræ and the little relative extent of the dorsal region, also in the cervical neural laminæ exceeding those of the dorsal vertebræ in antero-posterior extent, in the atlas having but one posterior articular surface for the axis, and in the large size of the transverse process of the atlas. The spine of the axis, however, has its upper part produced in a backward as well as in a forward direction; there are many caudal vertebræ, and there are caudal hypapophyses and chevron bones; the spines of the lumbar vertebræ are very long, and produced strongly forwards. Often the transverse processes of both the fourth and fifth cervical vertebræ are bifurcated; sometimes there are extra short transverse processes to the lumbar vertebræ, and the normal ones are produced strongly downwards and forwards.

Microcebus.

According to Dr. Peters †, there are seven lumbar vertebræ in this genus.

Nycticebinæ.

This family contains forms, the vertebral structure of which is aberrant, and singularly recalls in some of its details the family *Hominidæ* and the subfamily *Simiinæ*.

Atlas with less extended transverse processes than in the other *Lemuridæ*, and sometimes with two articular surfaces for junction with the axis; spine of axis bifid or trifid; transverse process of the third cervical vertebra often, those of the fourth and fifth cervicals always, bifurcated; cervical vertebræ very short, and therefore quite unlike those of *Lemur* and *Indris*; dorsal and lumbar spines all backwards inclined, or sometimes the latter only very slightly forwards; increase in length and breadth of dorsal vertebræ backwards very slight; metapophyses mostly inconspicuous ‡, but sometimes developed in the cervical region; anapophyses but little developed; sacrum long and tapering posteriorly; caudal vertebræ few, no caudal hypapophyses; increase in breadtb of the lumbar vertebral bodies as compared with the dorsal at its minimum; neurapophyses sometimes directly perforated by the spinal nerves; ribs from fourteen to sixteen pairs; dorsal region much relatively extended, cervical region very little so.

Nycticebus.

Spine of third cervical vertebra generally bifurcated; dorsal ver-

* This, as well as many of the above characters, is noticed by Prof. Owen in his remarks on the skeleton of this species (see Osteological Catalogue, vol. ii. p. 717). He also notices that the Paris specimen has an extra pair of ribs.

† Reise nach Mossambique, p. 17.

‡ *I.e.* not projecting strongly upwards as in the Long-tailed Monkeys and Lemurs.

tebræ sixteen, lumbar vertebræ seven or eight in number; spines of lumbar vertebræ all backwards inclined*; no distinct lumbar anapophyses†; neurapophyses not perforated; two articular surfaces on the atlas for its union with the axis; cervical spines short.

Loris.

Spines of third and fourth cervical vertebræ very minute; neck so short that the breadth of the cervical vertebræ equals two-thirds their total length; spines of lumbar vertebræ nearly vertical; distinct though short lumbar anapophyses†; articular surfaces for the junction of the atlas with the axis not continuous; dorsal vertebræ fourteen or fifteen, lumbar vertebræ nine in number; cervical spines short.

Perodicticus and Arctocebus.

Cervical spines very long, the last the longest; distinct cervical metapophyses; neurapophyses of dorsal vertebræ directly perforated

Fig. 12.

Seven trunk-vertebræ of Potto (*Perodicticus*), from the British Museum. Nat. size.

by spinal nerves; spines of lumbar vertebræ vertical or very slightly inclined forwards; articular surfaces for the junction of the axis with the atlas continuous, as in *Lemur*; dorsal vertebræ fourteen or fifteen, lumbar vertebræ seven or eight in number; sometimes traces of hyperapophyses.

Galagininæ‡.

Atlas with only one articular surface behind; axis with a simple or bifurcated spinous process; spines of all the cervical vertebræ posterior to the axis almost or quite obsolete; thirteen dorsal, and six lumbar vertebræ; twelfth or thirteenth dorsal spine turned forwards; metapophyses and anapophyses distinct; hyperapophyses (fig. 8, *h*) in lumbar region at their maximum; first dorsal spine long.

Tarsidæ.

Cervical spines almost obsolete; first dorsal spine very small;

* Noticed by De Blainville, 'Ostéographie,' *Lemur*, p. 14.

† Noticed by De Blainville, 'Ostéographie,' *Lemur*, p. 16. The metapophyses are described by Prof. Owen in part 1 of his Memoir on the *Megatherium*, 'Phil. Trans.', part 2 for 1851, p. 728.

‡ Unfortunately I have only been able to observe two skeletons of this subfamily—one of *Galago* (*Otolicnus*) *allenii*, the other of *Galago* (*Hemigalago*) *demidoffii*.

lumbar anapophyses very faintly marked; metapophyses more distinct in the three first caudals than in all the rest of the spine; no hyperapophyses.

CHEIROMYIDÆ.

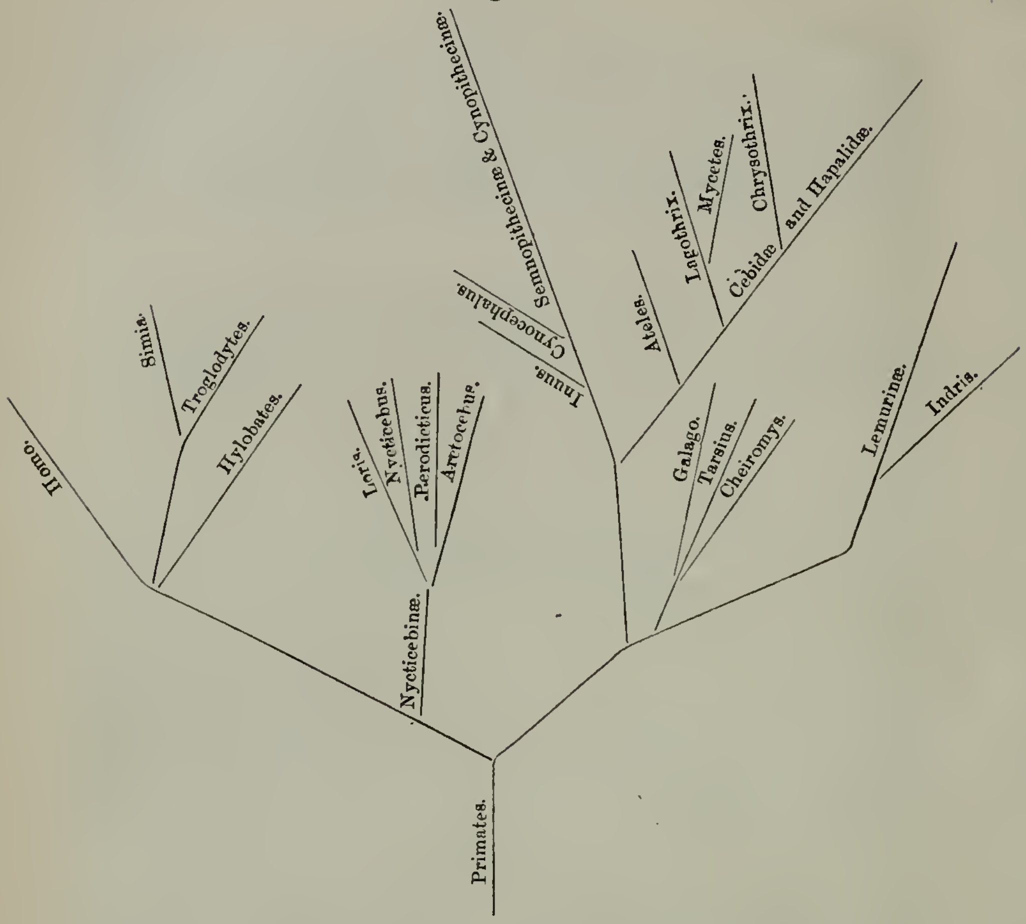
Atlas with two distinct articular surfaces for axis; spines of third, fourth, fifth, sixth, and seventh cervical vertebræ almost obsolete; thirteenth dorsal spine turned forwards; a process like a second anapophysis in some lumbar vertebræ; transverse process of fourth cervical vertebra bifurcating; nine pairs of true ribs; two sacral vertebræ; no hyperapophyses; no distinct metapophyses or anapophyses in the cervical region.

To sum up the results of these observations, the Primates present us (as regards their vertebral column only) with four principal types of structure, well represented, respectively, by (1) *Simia*, (2) *Cercopithecus*, (3) *Nycticebus*, and (4) *Lemur*,—the first having, however, many points in common with the third, and the second with the fourth; so that the affinities between the various groups of the order (as regards their spinal characters) may be represented under the symbol of a tree. The trunk of such a tree (fig. 13) divides into two main branches—one of them representing the forms possessing few caudal vertebræ, an elongated tapering sacrum, inconspicuous metapophyses or anapophyses, neural spines of trunk nearly always vertical or backwardly inclined, and that of the axis more or less bifid or trifid, cervical vertebræ short, and cervical spines sometimes very produced—that is to say, the forms included in the family *Hominidæ* and in the subfamilies *Simiinæ* and *Nycticebinæ*; the other main branch representing all the rest of the order, and possessing the characters attributed above to the *Simiidæ* (other than the *Simiinæ*), the *Cebidæ*, the *Hapalidæ*, and the *Lemuroidea* in common.

The first main branch gives off a secondary one to represent the *Nycticebinæ*, and then divides into three others for (1) *Homo*, (2) for *Troglodytes* and *Simia*, and (3) for *Hylobates*. The second main branch bifurcates,—its first division representing the *Simiidæ* other than the *Simiinæ*, together with the *Cebidæ* and *Hapalidæ*; its second denoting the *Lemuroidea* other than the *Nycticebinæ*. From both the *Semnopithecinæ* and *Cynopithecinæ Inuus* and *Cynocephalus* distinguish themselves as separate twigs; and *Ateles* diverges from the *Cebidæ* generally, and very interestingly parallels *Hylobates* in its long cervical neural laminæ, backwards inclined neural spines of trunk-vertebræ, large transverse diameter of thorax, and slightly marked metapophyses and anapophyses. *Mycetes* and *Lagothrix* also, with their marked hyperapophyses, and *Chrysothrix*, with its undivided caudal transverse processes, are also special forms. The genera *Galago*, *Tarsius*, and *Cheiromys*, with their rudimental cervical spines, diverge so much from the typical Lemurs that they might almost be represented as a distinct primary division of the second main branch, instead of a subdivision of that bifurcation which culminates in *Lemur*, and which gives off a twig to represent *Indris*

—a form, as we have seen, almost, if not quite, as distinct amongst the *Lemuroidea* as *Homo* is amongst the *Anthropoidea*.

Fig. 13.



Thus the vertebral column in Primates, though it does not give us such marked and distinct characters as are presented by the cranium and dentition, yet exhibits peculiarities which are far from being destitute of significance. These peculiarities, if considered alone, would lead to an arrangement of groups and an interpretation of affinities somewhat differing from, yet in part agreeing with, the classification founded on cranial and dental characters; so that the study of that part of the axial skeleton in the Primates which is posterior to the skull may fairly be regarded as well adapted to assist us in the determination of the natural affinities of the groups composing the order, while at the same time it conduces to a correct appreciation of the relations existing between the human vertebral column and that of the ordinary four-footed mammals.